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FOSSIL CORALS OF GREAT BRITAIN.
PART IV.

FOSSIL BRACHIOPODA
OF
GREAT BRITAIN.
PART IV.
WITH A GENERAL INTRODUCTION.

FOSSIL SHELLS OF THE CHALK.
PART I.—CEPHALOPODA.

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FOSSIL REPTILIA OF GREAT BRITAIN.
PART IV.—WEALDEN.

1853.

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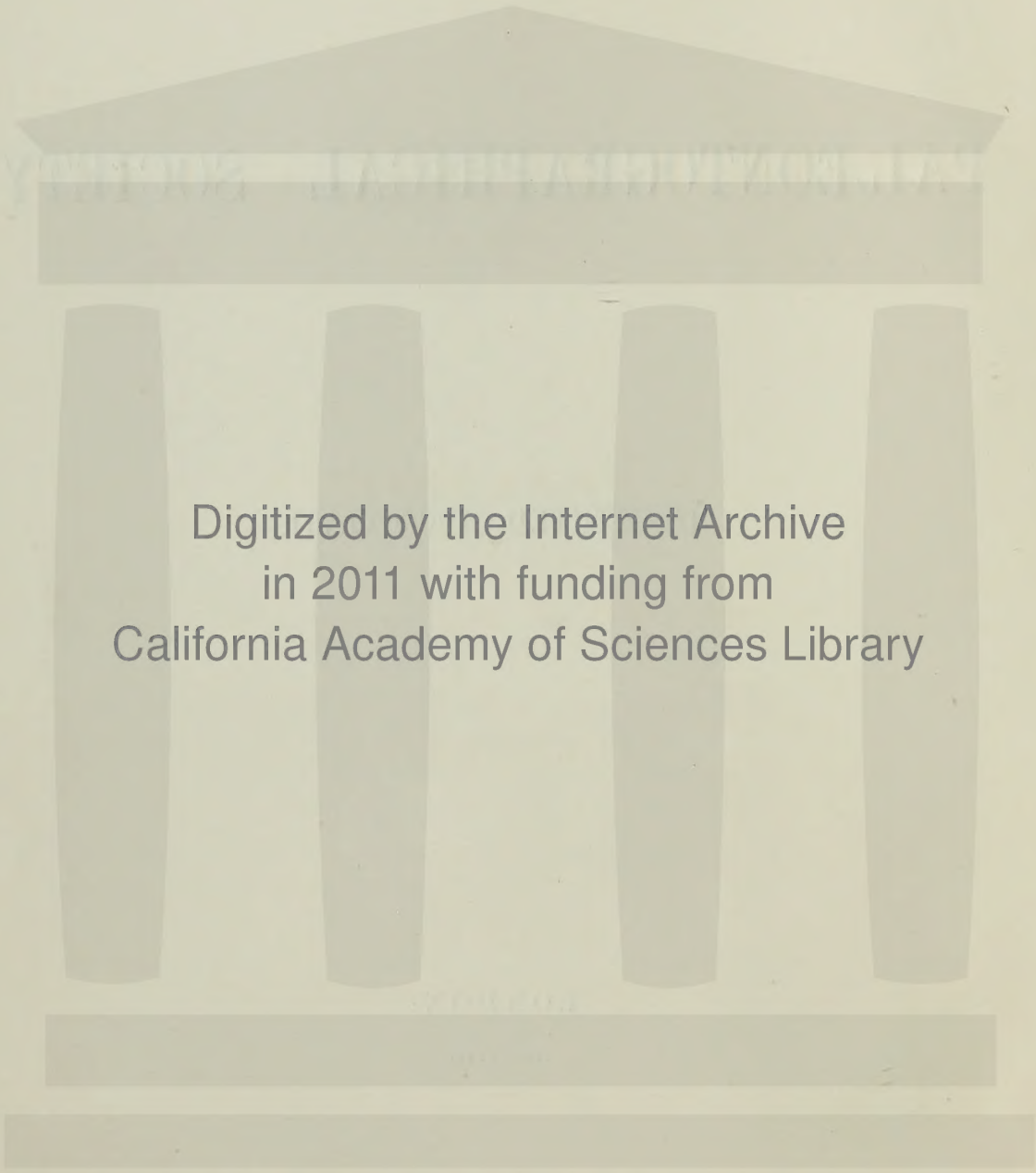

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A MONOGRAPH

OF THE

BRITISH FOSSIL CORALS.

BY

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That the Society formed be called the Palæontographical Society, and that it shall have for its objects the illustration and description of British Fossil Organic Remains.

II.

Each Subscriber of One Guinea, or more, annually, shall be considered a Member of the Society. Such subscription to be paid in advance, and shall be due on the 1st day of January, 1847, and each succeeding year.

III.

A Member shall, for each Guinea subscribed annually, be entitled to one copy of every publication issued by the Society, for the year to which his subscription relates. But no Member shall be entitled to receive his copy, or copies, until his subscription has been paid.

IV.

The number of copies of the Society's publications shall be limited to the number of Members, unless otherwise directed by the Council.

V.

The business of the Society shall be conducted by a President, Treasurer, Hon. Secretary, and a Council of sixteen Members, who shall be elected at a General Meeting of the Members, to be held annually in London.

VI.

The accounts of the receipt and expenditure of the Society shall be examined annually by two Auditors appointed by the Council; the Auditors to be Members of the Society, who are not Members of the Council, and their statement circulated among the Subscribers.

VII.

That the Editors of works published by the Society be entitled to a number of copies of their works, not exceeding twenty-five, as may be decided by the Council.

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They are delivered, free of expense, within three miles of the General Post Office, London.

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The Council, desirous of imposing as little trouble as possible upon the Local Secretaries, particularly request that all subscriptions be paid by Members directly to the Treasurer, Searles Wood, Esq., 28, Fortess Terrace, Kentish Town, by Post Office Order on the *London Office*, or by Cheque on a *London* Banker. And, as there is no other capital for conducting the affairs of the Society than the subscriptions paid in advance, the Country Members are respectfully reminded that an *early* remittance is absolutely necessary.

As the quantity of plates and letterpress to be delivered to the Subscribers annually will be increased in proportion to the extension of the Society, the Members are respectfully urged to obtain as many new Subscribers, and at as early a period, as possible.

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DESCRIPTION

OF

THE BRITISH FOSSIL CORALS.

CHAPTER XV.

CORALS FROM THE DEVONIAN FORMATION.

The British Corals appertaining to the Devonian Formation are in general so completely imbedded and filled up with extraneous calcareous matter, that it is difficult to distinguish them otherwise than by the study of polished sections; but these usually show their structural characters in a very satisfactory manner, and enable the Palæontologist to recognise their zoological affinities. In France and in Germany the corals belonging to the same geological period are, on the contrary, often met with in an excellent state of preservation, and show all the details of their exterior surface, as well as the most minute parts of their interior organisation; but in this Monograph we have only figured British specimens. For the more complete representation of some species, we must consequently refer to other works, such as the excellent publication of 'Goldfuss on the German fossils,' and our *Monographie des polypiers des terr. Palæozoiques.* The corals discovered in the Devonian Formation, in the different parts of the world, belong to about 150 well-defined species, 46 of which have been met with in England. To these British corals may be added 3 species that are very imperfectly known, casts only of them having been as yet found, and few specimens that have received names, but are not determinable zoologically. Almost half of the British species have not as yet been found in other countries; 22 have been discovered on the Continent; and we may also remark that most of the American species are not seen here, only 6 of the latter have been met with in England; among these, 5 are at the same time Continental. The corals belonging to the family of the Cyathophyllidæ are very predominant, and form 33 of the 46 above-mentioned species. The family of Favositidæ is represented by 10 species, and the three remaining species belong one to each of the three families Stauridæ, Milleporidæ, and Poritidæ; with the exception of one species of Poritidæ that we have not seen, all these fossils belong, therefore, to the two sub-orders *Zoantharia tabulata* and *Zoantharia rugosa*, one of which has no

representative in the actual Fauna, nor in the Tertiary and Secondary Formations. Three of these Devonian fossils exist also in the Silurian rocks, but all the others appear to be peculiar to the Devonian period.

The principal localities from which these corals have been obtained are Torquay, Plymouth, and Newton Bushel. The specimens described in this Monograph belong mostly to the collections of Dr. Battersby, Mr. Pengelly, Mr. Bowerbank, Mr. Phillips, and the Geological Society; some of the latter were more particularly valuable to us, being the type specimens of the species described in 1840 by Mr. Lonsdale in the memoir of Messrs. Sedgwick and Murchison, on the Devonian Formation of England.

Family MILLEPORIDÆ, (*Introd.*, p. lviii.)

1. *Genus* Heliolites, (*Introd.*, p. lviii.)

Heliolites Porosa. Tab. XLVII, figs. 1, 1*a*, 1*b*, 1*c*, 1*d*, 1*e*, 1*f*.

Heliolithe pyriforme, à étoiles d'une demi-ligne de diamètre, &c., *Guettard*, Mém. sur les Sc. et les Arts, vol. iii, p. 454, pl. xxii, figs. 13 and 14, 1770.

Astrea porosa, *Goldfuss*, Petref. Germ., vol. i, p. 64, tab. xxi, fig. 7, 1826.

Heliopora pyriformis, *De Blainville*, Dict. Sc. Nat., vol. lx, p. 357, 1830; Manuel d'Actinologie, p. 392.

— — *Steininger*, Mém. Soc. Géol. France, vol. i, p. 346, 1831.

— interstincta, *Bronn*, Leth. Geogn., vol. i, p. 48, tab. v, fig. 4, 1835.

Porites pyriformis, *Lonsdale*, Geol. Trans., 2d series, vol. v, pl. lviii, fig. 4, 1840. (Not Lonsdale in Silur. System.)

— — *Phillips*, Palæoz. Foss., p. 14, pl. vii, fig. 19, 1841.

Explanaria interstincta, *Geinitz*, Grundr. der Verst., p. 568, 1845-46.

Geporites porosa and Phillipsii, *D'Orbigny*, Prodr. de Paléont., vol. i, pp. 108, 109, 1850.

Heliolites porosa, *Milne Edwards* and *Jules Haime*, Pol. Foss. des Terr. Palæoz., p. 218, 1851.

Palæopora pyriformis, *M'Coy*, Brit. Palæoz. Fossils, p. 67, 1851.

Corallum compound, forming generally a globular mass, which in some specimens is subgibbose, in others cylindrical; sometimes composed of very distinct superposed layers. *Calices* somewhat unequal in size, placed rather irregularly at distances equal to about two or three times their diameter, surrounded by a very thin rim, and slightly elevated above the general surface of the corallum. The calicular fossula large and rather deep. *Septa*, twelve in number, somewhat unequal in size alternately, almost straight, thick exteriorly, and extending almost to the centre of the visceral cavity. The pores of the *Cœnenchyma* small, almost equal in size and nearly regularly hexagonal; one eighth of a line in diameter. Calices almost half a line in diameter.

A vertical section of this corallum shows that the *Tabulæ* are horizontal, or slightly

oblique, and less closely set than in the other species. The laminæ of the tubes of the Cænenchyma are thin, but assume the appearance of vertical lines, much more strongly marked than those formed by the dissepiments. The latter appear to be quite independent of the adjacent tubes, and are not, in general, placed so as to correspond together horizontally.

Found at Torquay, Teignmouth Beach, Walcombe Beach, Woolborough Quarry, Babbacombe, Newton, Plymouth, and Marychurch; and also in Germany in the Eifel Mountains, and on the banks of the river Lahn.

Specimens are in the Museums of the Geological Society of London, of Practical Geology, and in the collections of Messrs. J. S. Bowerbank, Battersby, and Pengelly.

This coral has often been confounded with the *Heliolites interstincta*,[1] but differs from it by the calices being much less closely set, and by the Cænenchyma being more developed. In *H. Murchisoni*[2] the calices are also very distant, but in the above-described species the tabulæ are less numerous, and the dissepiments of the Cænenchyma are thinner than the vertical laminæ of the tubes of the same tissue, and do not correspond among themselves so as to constitute horizontal strata.

We have not adopted the name of *Pyriformis*, which Blainville, Mr. Lonsdale, and Mr. M'Coy apply to this species, as having been given to it by Guettard; because the French epithet *pyriforme* was given by Guettard himself to several other species, but not made use of as a specific name, and because Goldfuss had called it *Astrea porosa* before Blainville proposed employing the former designation.

We also see no reason for giving to the genus, to which this specimen belongs, the name of *Palæopora* in preference to that of *Heliolites*, the latter having been revived from Guettard's writings in 1846 by Mr. Dana, and the former having been introduced only in 1848 by Mr. M'Coy. The name of *Géoporites*, given more recently to the same group of corals by M. D'Orbigny, must also, in consequence of the law of priority, be rejected.

2. Genus Battersbyia.[3]

Battersbyia inæqualis. Tab. XLVII, figs. 2, 2*a*, 2*b*.

Battersbyia inæqualis, *Milne Edwards* and *Jules Haime*, Monogr. des Pol. Foss. des Terr. Palæoz., p. 227, 1851.

Corallum composite, massive. *Corallites* very unequal in size, with thick non-costulate walls, united together by a thin, spongiose, irregular Cænenchyma. *Calices* almost circular, never subpolygonal. *Septa* small but well defined, somewhat unequal in size alternately, rather thick towards the wall, but very thin inwardly; 26 of them in the large calices. *Tabulæ* appearing to be vesicular, and filling the visceral chambers. *Cænenchyma*

[1] *Astrea porosa*, Hisinger, Leth. Succ., p. 98, tab. xxviii, fig. 2, 1837.

[2] Milne Edwards and Jules Haime, Pol. Foss. des Terr. Palæoz., p. 215, 1851.

[3] Milne Edwards and Jules Haime, Polyp. Foss. des Terr. Palæoz., pp. 151, 227, 1851.

as in the other Madreporites. Diameter of the large individuals rather above one and a half line; that of the young corallites less than half a line, and between these two extremes numerous differences.

This remarkable fossil cannot be placed in any of the generical divisions enumerated in the Introduction to this Monograph, and constitutes the type of a new division, which we have established in our work on the Corals of the Palæozoic formations. It is characterised by its spongy Cænenchyma, and its subvesicular Tabulæ.

Found at Teignmouth by Dr. Battersby.

We have dedicated this genus to Dr. Battersby, of Torquay, in commemoration of the liberality with which that gentleman has communicated to us, for description, a most valuable series of Devonian fossils.

Family FAVOSITIDÆ, (*Introd.*, p. lx.)

Sub-family FAVOSITINÆ, (*Introd.*, p. lx.)

1. *Genus* FAVOSITES, (*Introd.*, p. lx.)

1. FAVOSITES GOLDFUSSI. Tab. XLVII, figs. 3, 3*a*, 3*b*, 3*c*.

CALAMOPORA GOTHLANDICA (pars), *Goldfuss*, Petref., p. 78, pl. xxvi, figs. 3*b*, 3*c*, 1829. (Cœt. exclusis.)
FAVOSITES — *Phillips*, Palæoz. Foss., p. 16, pl. vii, fig. 21, 1841.
CALAMOPORA — ? *Ad. Rœmer*, Verst. des Harzgeb., p. 6, tab. iii, fig. 2, 1843.
FAVOSITES — ? *Lonsdale*, in Strzelecki's Description of New South Wales and Van Diemen's Land, p. 266, 1845.
— GOTHLANDICUS, *Steininger*, Verst. des Ueberg. geb. der Eifel, p. 9, 1849.
— GOLDFUSSI, *D'Orbigny*, Prodr. de Paléont., vol. i, p. 107, 1850.
— — *De Verneuil* and *J. Haime*, Bull. de la Soc. Géol. de France, 2d ser., vol. vii, p. 162, 1850.
— — *Milne Edwards* and *J. Haime*, Pol. Foss. des Terr. Palæoz., p. 235, pl. xx, fig. 3, 1851.

Corallum composite, forming a convex globular, or pyriforme mass. *Calices* for the most part nearly of the same size, but sometimes intermingled with some very small ones. The inner surface of the *walls* rendered rugose by the presence of small points; their sides unequally developed, and presenting 1, 2, or 3 vertical rows of small pores or holes (almost always 2 rows), which are regularly circular, more closely set than in *F. gothlandica*, and sometimes alternate, but in other parts opposite. Diagonal of the large corallites somewhat more than a line.

Found at Barton, near Torquay, by Dr. Battersby. Mr. Phillips mentions its having been met with also at Shoreham Point, Plymouth, and Babbacombe. The same species is

found also at Nehou and Visé, in France; at Millar, in Spain; at Paffrath, in the Eifel and in the Hartz Mountains; in the Oural, in Russia; in the States of Indiana, Ohio, and Kentucky, in America; and (according to Mr. Lonsdale) at Yass plains, in New South Wales.

This fossil was, till of late, confounded with *F. gothlandica*,[1] to which it bears in fact great resemblance exteriorly; but it differs from it by the mural pores being more distant from each other, and arranged in two vertical lines on each side of the wall. In *F. alveolaris*[2] and *F. aspera*[3] these pores are always situated in the angles formed by the prismatic walls of the corallites, and in *F. basaltica*[4] and *F. polymorpha*[5] they only form a single line, placed in the middle of each side of the wall. In *multipora*[6] and *F. Troosti*,[7] on the the contrary, there are always three series of pores on each side of the wall. *F. parasitica*[8] and *F. Forbesi*[9] differ from *F. Goldfussi* by their calices being very unequal in size, and *F. Hisingeri* may be distinguished from the latter by the great development of the dissepiments. As to the ramose species of Favosites, they are sufficiently distinct from the above-described fossil, in consequence of their form.

2. Favosites reticulata. Tab. XLVIII, figs. 1, 1*a*, 1*b*.

Calamopora spongites (var. ramosa), *Goldfuss*, Petref. Germ., vol. i, p. 80, tab. xxviii, fig. 2*a*—*g*, 1829. (Cœt. excl.)

Alveolites reticulata, *De Blainville*, Dict., vol. lx, p. 369, 1830.—Man., p. 404.

Calamopora spongites, *Geinitz*, Grundr. der Verst., pl. xxiii a, fig. 13, 1845-46.

— — *Keyserling*, Reise in das Petsch., p. 178, 1846.

Alveolites spongites, *D'Orbigny*, Prodr. de Paléont., vol. i, p. 108, 1850. (Not *Steininger*.)

Favosites Orbignyana, *De Verneuil* and *Jules Haime*, Bull. Soc. Géol. de France, 2d ser., vol. vii, p. 162, 1850.

— reticulata, *Milne Edwards* and *Jules Haime*, Pol. Foss. des Terr. Palæoz., p. 241, 1851.

Corallum dendroid, composed of thick branches (from half a line to one line in diameter), which intermingle much, and often coalesce. *Calices* almost equal in size, with thick walls, and having somewhat less than half a line in diameter.

Found at Torquay in England, at Nehou and Brest in France, Palapaya and Ferrones in Spain, Eifel in Germany, and (according to M. Keyserling) at Uchta in Russia.

[1] *Calamopora gothlandica* (pars), Goldfuss, Petref. Germ., t. i, p. 78, pl. xxvi, figs. 3*a* and 3*e*, 1829.

[2] *Calamopora alveolaris* (pars), Goldfuss, ibid., p. 77, pl. xxvi, figs. 1*a*, 1*e*.

[3] Id. (pars.), Goldfuss, ibid., p. 77, pl. xxvi, fig. 1*b*.

[4] *Calamopora basaltica*, Goldfuss, ibid., p. 78, pl. xxvi, figs. 4*c*, 4*d*.

[5] *Calamopora polymorpha*, var. *tuberosa*, Goldfuss, ibid., p. 79, pl. xxvii, figs. 2*b*, 2*c*, 2*d*, 3*b*, 3*c*. (Cœt. excl.)

[6] Lonsdale, Silur. Syst., p. 683, pl. xix, bis fig. 5, 1839.

[7] Milne Edwards and Jules Haime, Pol. Foss. des Terr. Palæoz., p. 238, pl. xviii, fig. 1.

[8] Tab. xlix, fig. 2.

[9] *Calamopora basaltica* (pars), Goldfuss, Petref. Germ., t. i, p. 78, tab. xxvi, fig. 4*b*, 1829.

We have, provisionally, admitted, as forming distinct species, various ramose Favosites, which have previously been described as such by Blainville, but which may probably, when better known, be found to be only varieties of the same species. Such are *F. reticulata*, *F. cervicornis*,[1] and *F. dubia*.[2] The latter differs, however, from the first by its branches not being coalescent, nor so closely set, and by the calices being rounded and obliquely placed on the surface of the branches. *F. cervicornis* has its calices more unequal in size, its walls thinner, and its branches larger and more irregular. All these have only a single line of pores on each side of the walls, and these pores are large and placed at a distance from each other.

3. Favosites cervicornis. Tab. XLVIII, fig. 2.

Calamopora polymorpha, var. Ramosa divaricata, *Goldfuss*, Petref., vol. i, p. 79, pl. xxvii, figs. 3*a*, 4*a*, 4*b*, 4*c*, 1829. (Cœt. exclus.)

Alveolites cervicornis, *De Blainville*, Dict. Sc. Nat., vol. lx, p. 369, 1830.—Man., p. 405.

Thamnopora Milleporacea (pars.), *Steininger*, Mém. Soc. Géol. de France, vol. i, p. 338, 1831.

Calamopora polymorpha, *Ad. Rœmer*, Verst. des Harzgeb., p. 6, tab. ii, fig. xvi, 1843.

Favosites cronigera and Alveolites celleporatus, *D'Orbigny*, Prodr. de Paléont., vol. i, p. 107, 1850.

— — *De Verneuil* and *Jules Haime*, Bull. Soc. Géol. de France, 2d ser., vol. vii, p. 102, 1850.

— cervicornis, *Milne Edwards* and *Jules Haime*, Pol. Foss. des Terr. Palæoz., p. 243, 1851.

— polymorpha, *M'Coy*, Brit. Palæoz. Foss., p. 68, 1851.

Corallum subdendroid. *Calices* unequal in size; walls somewhat thick.

Found at Torquay, and, according to Professor M'Coy, at Newton Bushel, Teignmouth, New Quay, Plymouth, and Bedruthen Slope, St. Eual; at Mons in Belgium; near Brest in France; at Ferrones and Consejo de Llaviera in Spain; and in the Eifel, at Heiflerstein, Villmar, and Bensberg, in Germany.

This coral differs from *F. reticulata*[3] and *F. dubia*[4] by its branches being thicker and more irregular, its calices being more unequal in size, and its walls being thinner.

4. Favosites dubia.

Calamopora polymorpha, var. gracilis, *Goldfuss*, Petref. Germ., vol. i, p. 79, tab. xxvii, fig. 5, 1829.

Alveolites dubia, *Blainville*, Dict., vol. lx, p. 370, 1830.—Man., p. 405.

Thamnopora madreporacea, *Steininger*, Mém. de la Soc. Géol., vol. i, p. 338, 1831.

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[1] Tab. xlviii, fig. 2.

[2] *Calamopora polymorpha*, var. *gracilis*, Goldfuss, Petref. Germ., t. i, p. 19, tab. xxvii, fig. 5, 1829.

[3] Tab. xlviii, fig. 1.

[4] *Calamopora polymorpha*, var. *gracilis*, Goldfuss, Petref. Germ., t. i, p. 19, tab. xxvii, fig. 5, 1829.

FAVOSITES POLYMORPHA, *Phillips*, Palæoz. Foss., p. 15, pl. viii, fig. 20, 1841.
ALVEOLITES CERVICORNIS, *Michelin*, Icon., p. 187, pl. xlviii, fig. 2, and pl. xlix, fig. 3, 1845.
— — *D'Orbigny*, Prodr. de Paléont., vol. i, p. 107, 1850.
FAVOSITES DUBIA, *Milne Edwards* and *Jules Haime*, Pol. Foss. des Terr. Pal., p. 243, 1851.

Corallum dendroid; its branches placed wide apart, not coalescent, and about half a line in diameter. *Calices* somewhat oblique, deep, with the exterior part of their edge rounded or subpolygonal; walls thick; some very small calices often situated between the large ones, which are about two thirds of a line in diameter; a single line of large pores on each side of the walls.

Found at Torquay, and, according to Professor Phillips, at Lee Quarry near Combe Martin; West Hagginton; Hillsborough near Ilfracombe; Babbacombe, Hope, Sharkham Point, Mudstone Bay; in France, at Ferques (Pas-de-Calais), Viré, Chassegrain (Sarthe); in Germany at Bensberg; in America at the Falls of Ohio, and in the Clarke county.

This coral differs from *F. reticulata*[1] and *F. cervicornis*[2] by the obliquity of its calices, —a character which gives it some resemblance to Alveolites.

The only British specimen of this species that we have seen belongs to the collection of the Geological Society, but is in too bad a state of preservation to be worth being represented in the plates joined to this Monograph.

5. FAVOSITES FIBROSA. Tab. XLVIII, figs. 3, 3*a*, 3*b*.

CALAMOPORA FIBROSA, var. TUBEROSA RAMOSA, *Goldfuss*, Petref. Germ., vol. i, p. 82, tab. xxviii, fig. 3*a*, 3*b*, 1829. (Cœt. excl.)
FAVOSITES MICROPORUS, *Steininger*, Mém. Soc. Géol. de France, vol. i, p. 337, 1831.
ALVEOLITES FIBROSA, *Lonsdale*, Sil. Syst., p. 683, pl. xv, fig. 1, 1839.
FAVOSITES FIBROSA (pars), *Lonsdale*, ibid., p. 683, pl. xv bis., fig. 6, 1839 (but not fig. 7).
— — *Phillips*, Palæoz. Fossils, p. 17, pl. ix, fig. 25, 1841.
CALAMOPORA FIBROSA, *Ad. Rœmer*, Verst. des Harzgeb., p. 6, pl. iii, fig. 4, 1843.
— — *Keyserling*, Reise in das Petschora land, p. 177, 1846.
ALVEOLITES FIBROSUS, *D'Orbigny*, Prodr. de Paléont., vol. i, p. 108, 1850.
FAVOSITES FIBROSA, *Milne Edwards* and *Jules Haime*, Pol. Foss. des Terr. Pal., p. 244, 1851.

Corallum massive, very convex; sometimes subpyriform or sublobate. *Corallites* prismatical, radiating from the base of the corallum to its surface; straight, or slightly flexuous, and almost equal in size. *Tabulæ* very closely set (12 or 15 in the space of a line). Mural pores large in proportion to the size of the corallites, closely set, alternating with the tabulæ, and arranged in single vertical lines at the angles of the prismatical walls. Diameter of the calices about one tenth of a line.

Found in the Devonian formation at Torquay, and, according to Mr. Phillips, at Darlington near Totness, Sharkham Point, and Babbacombe; in France, at Viré (Sarthe); in Germany in the Eifel and in the Hartz Mountains. Found also in the superior

[1] Tab. xlviii, fig. 1. [2] Ibid., fig. 2.

Silurian deposits at Storderley Edge (Upper Ludlow Rocks), Larden, and, according to Mr. Lonsdale, at Churn-bank, on Palmer's Kairn near Ludlow; in Ireland, according to Mr. M'Coy, in numerous localities of the counties of Galway, Kerry, Wexford, Kildare, Mayo, Tyrone, Waterford, and Wicklow; in Russia at Waschkina (according to Keyserling); in America at Casskill, and at Lexington, Kentucky (Goldfuss). Found in the inferior Silurian deposits at Landovery.

We are inclined to think that it is by mistake that Professor M'Coy mentions this species as having been met with in the carboniferous formation in Ireland, and presume that the fossil so alluded to by that geologist was the *Alveolites septosa.*

The above-described species is easily distinguished from all the other species of Favosites by the smallness of its calices. It resembles *F. alveolaris*[1] and *F. aspera*[2] by the angular position of its mural pores; but these two species differ from it by the calices being much more irregular in size, as well as much larger.

We have not remarked any material difference between the specimens found in the Devonian and the Silurian formations; but all these corals are so ill-preserved, that we are not inclined to attach much importance to that supposed specific identity.

2. *Genus* Emmonsia.[3]

Emmonsia hemispherica. Tab. XLVIII, figs. 4, 4*a*.

Favosites alveolaris, *Hall*, Geol. of New York, p. 157, No. 31, figs. 1, 1*a*, 1843. (No. 8 of Blainville.)

Favosites hemispherica, *Vandell* and *Shumard*, Contrib. to Geol. of Kentucky, p. 7, 1847.

Alveolites hemispherica, *D'Orbigny*, Prod. de Paléont., vol. i, p. 49, 1850.

Favosites hemispherica, *Jules Haime* and *Verneuil*, Bull. Soc. Géol. de France, 2d ser., vol. vii, p. 162, 1850.

Emmonsia hemispherica, *Milne Edwards* and *Jules Haime*, Pol. Foss. des Terr. Palæoz., p. 247, 1851.

Corallum composite, forming a subspherical mass, which becomes sometimes very tall, and composed of superposed layers. *Calices* irregular, polygonal, and varying in size. *Septa* (12) well developed, straight or slightly curved, and extending to the centre of the upper tabulæ. Mural *pores* large, placed at about a quarter of a line apart, and arranged in pairs on some of the sides of the wall, but forming single lines on others. *Tabulæ* very closely set, somewhat irregularly horizontal. In the visceral chambers, where they are broken down, they leave fragments adhering to the walls; and in general, above the space included between two of these fragments, a third fragment exists, so as to constitute an

[1] *Calamopora alveolaris* (pars), Goldfuss, Petref. Germ., t. i, pl. xxvi, figs. 1*a*, 1*c*, 1826.

[2] *Calamopora alveolaris* (pars), Goldfuss, ibid., tab. xxvi, fig. 1*b*.

[3] Milne Edwards and Jules Haime, Monographie des Polyp. Foss. des Terr. Palæoz.; Archives du Museum, vol. v, p. 246, 1851.

alternate mode of superposition. Great diagonal of the calices about half a line; the tabulæ are placed at about one tenth of a line apart.

Found in the Devonian formation at Torquay; in Spain at Contejo de Castrillon, near Aviles; in America at Caledonia, New York, at the Falls of Ohio, at Charleston Landing (Indiana), in the Isle of Mackinaw, and, according to Mr. Hall, at Williamsville, Erie county. Found also in the superior Silurian deposits at Springfield, Ohio, and in Perry county, Tennessee.

The genus Emmonsia contains two other species—*E. alternans*[1] and *E. cylindrica*.[2] The first differs from the species here described by the alternate arrangement of the mural edges, by the incomplete tabulæ being more regular, and by its calices being larger. *E. cylindrica* has calices still larger, and often circular; it is also characterised by the existence of four or five lines of pores on each side of the walls.

3. *Genus* Alveolites, (p. lx.)

1. Alveolites suborbicularis. Tab. XLIX, figs. 1, 1*a*.

Alveolites suborbicularis, *Lamarck*, Hist. des Anim. sans Vert., vol. ii, p. 186, 1816; 2d ed., p. 286.
— escharoides, *Lamarck*, Hist. des An. sans Vert., vol. ii, p. 186, 1816; 2d ed., p. 286.
Escharites spongites, *Schlotheim*, Petrefactenkunde, 1st part, p. 345, 1820.
Alveolites suborbicularis and escharoides, *Lamouroux*, Encycl. (Zooph.) pp. 41, 42, 1824.
Calamopora spongites, var. Tuberosa, *Goldfuss*, Petref. Germ., vol. i, p. 80, tab. ii, fig. 1*a*—*h*, 1829. (Cæt. excl.)
Alveolites escharoidea and suborbicularis, *De Blainville*, Dict. Sc. Nat., vol. lx, p. 269, 1830.—Manuel, p. 404.
— spongites, *Steininger*, Mém. de la Soc. Géol. de France, vol. i, p. 334, pl. 20, fig. 4, 1831.
Calamopora — *Morren*, Descr. Cor. in Belg. Rep., p. 74, 1832.
Favosites — *Phillips*, Palæoz. Foss., p. 16, pl. viii, fig. 23, 1841.
Calamopora suborbicularis, *Michelin*, Icon., p. 188, pl. 48, fig. 7, 1845.
— squamosa or imbricata, ibid., p. 189, pl. xlix, fig. 15, 1845.
Favosites suborbicularis and Alveolites tuberosa, *D'Orbigny*, Prod. de Palæont., vol. i, pp. 107, 108, 1850.
Alveolites — *Milne Edwards* and *Jules Haime*, Pol. Foss. des Terr. Palæoz., p. 255, 1851.

Corallum composite, forming irregular incrustated masses, which are in general fixed on ramose favosites or on a cyathophyllum, and are composed of superposed layers,

[1] Milne Edwards and Jules Haime, Pol. Foss. des Terr. Palæoz., p. 248, 1851.

[2] *Favosites cylindrica*, Michelin, Icon., p. 255, pl. lx, fig. 1, 1846.

terminated by an irregular or subgibbose surface. *Calices* very oblique, closely set (but unequally so), elongated transversely, subtriangular, and turned towards the edge of the corallum. The outer or under side of these calices bears interiorly a small elongated ridge, which appears to represent a septum, and is placed opposite to a small notch. Transverse diameter of the calices about two fifths of a line; small diameter about half that length.

Found in the Devonian deposits of Torquay, Tor Abbey, Babbacombe, Teignmouth, and, according to M. Phillips, at Hope.

Specimens are in the collections of the Geological Society, Messrs. Battersby and Pengelly at Torquay.

Alveolites Labechei[1] is a massive subgibbose species, very nearly allied to the above-described coral, but differs from it by the interior dentation of the calicular edge being but slightly developed, and by the calices being more irregular in size. In *A. Battersbyi*[2] the septum represented by this interior expansion is, on the contrary, formed by very strong spiniform processes, and the mural pores are very large.

In *A. compressa*[3] the calices are much more irregular, and the inner processes are very small.

The other species of this genus are not massive.

2. Alveolites Battersbyi. Tab. XLIX, figs. 2, 2*a*.

Alveolites Battersbyi, *Milne Edwards* and *Jules Haime*, Pol. Foss. des Terr. Palæoz., p. 257, 1851.

Corallum forming a subspherical mass. *Calices* unequal in size, and somewhat irregular. Vertical and horizontal sections show that the *walls* are thin, and perforated by large circular pores rather closely set, and that in different places they give rise to strong ascending spiniform processes, which, by their superposition, represent unpaired septa. *Tabulæ* very thin and irregular.

Found at Torquay. Specimens are in the collections of Dr. Battersby and of Mr. Pengelly.

This species is remarkable for the slight obliquity of its calices, the large size of its mural pores, and more especially for the great development of its septal processes.

3. Alveolites vermicularis. Tab. XLVIII, figs. 5, 5*a*.

Alveolites vermicularis, *M'Coy*, Ann. and Mag. of Nat. Hist., 2d ser., vol. vi, p. 377, 1850.
— — *M'Coy*, Brit. Palæoz. Foss., p. 69, 1851.

Corallum dendroid, with slender, cylindrical coalescent branches that bifurcate at

[1] Milne Edwards and Jules Haime, Pol. Foss. des Terr. Palæoz., p. 257.
[2] Tab. lxix, fig. 2. [3] Tab. xlix, fig. 3.

almost right angles. A vertical section shows that the corallites diverge from the centre towards the surface of the branches in an oblique ascendant direction, are somewhat flexuous, and terminate by a calicular margin that is prominent at its under part. The *walls* are thick. In some places the *tabulæ* appear closely set, but in most parts of the specimen submitted to our investigation they were completely destroyed. The indications of the mural pores were also obscure. Diameter of the branches about $1\frac{1}{2}$ line, that of the calices about $\frac{1}{5}$th of a line.

This Coral was found at Torquay by Dr. Battersby, and is known to us only by a polished specimen belonging to the collection of that palæontologist. We at first thought that it might be referred to the *Ceriopora Goldfussi* of Michelin, but Professor M'Coy, who appears to have had some better preserved specimens, has since that recognized the existence of triangular calices and a fissiparous mode of multiplication. He therefore places this fossil in the genus Alveolites, and after more ample investigation we have been led to adopt his opinion. Professor M'Coy adds that *Alveolites Vermicularis* is polymorphous and is met with at Teignmouth, at Newquay, and at Bedruthen Steps, St. Eual.

ALVEOLITES COMPRESSA. Tab. XLIX, fig. 3.

Corallum massive. *Calices* arranged in a circular manner round divers places on the surface of the corallum, compressed, elongated, and very unequal in size, the larger ones being about half a line across. *Walls* thick exteriorly, and convex. The three septal processes somewhat unequally developed; short, but quite distinct.

This species resembles *Alveolites orbicularis*[1] by its general appearance, but differs from it by the calices being much more unequal in size, arranged in circular lines, and provided with three septal processes that do not differ in size.

Found at Torquay by Mr. Pengelly.

Family PORITIDÆ, (p. lv.)

The singular fossil coral to which Goldfuss gave the name of *Pleurodictyum problematicum*[2] has been met with in the Meadsfoot Sands near Torquay, by Prof. Phillips;[3] but we have not as yet seen any British specimen of that species, and we must therefore refrain from describing it here. We hope to be able to have it figured in an appendix to our Monograph.

[1] Tab. xlix, fig. 1.

[2] Petref. Germ., vol. i, p. 113, pl. xxxviii, fig. 18. See also our Monographie des Polypiers Fossiles des Terrains Palæozoiques, p. 210, pl. xviii, figs. 3, 4, 5, 6.

[3] Palæozoic Fossils, p. 19, pl. xix, fig. 24.

Family STAURIDÆ, (p. lxiv.)

Genus METRIOPHYLLUM BATTERSBYI.

METRIOPHYLLUM BATTERSBYI. Tab. XLIX, fig. 4.

METRIOPHYLLUM BATTERSBYI, *Milne Edwards* and *Jules Haime*, Pol. Foss. des Terr. Palæoz., p. 318, 1851.

This species has been established by the study of a polished slab belonging to the collection of Dr. Battersby, and showing a transverse section made at a small distance below the calice. The quadrifascicular mode of arrangement of the septa is very distinct. The principal septa are forty-eight in number, somewhat thick, and extending to the centre of the coral; they alternate with an equal number of smaller ones which are also thinner; towards the middle of each group they are slightly flexuous, and towards the outer part they become shorter and somewhat oblique. Some dissepiments are also visible. Diameter about eight lines.

Found at Torquay.

This species differs from *Metriophyllum Bouchardi*[1] by its septæ being twice as numerous and slightly thickened near the centre.

Family CYATHOPHYLLIDÆ, (p. lxv.)

1. *Genus* AMPLEXUS, (p. lxvi.)

AMPLEXUS TORTUOSUS. Tab. XLIX, figs. 5, 5*a*.

AMPLEXUS TORTUOSUS, *Phillips*, Palæoz. Foss., p. 8, pl. iii, fig. 8, 1841.
— — *Milne Edwards* and *Jules Haime*, Pol. Foss. des Terr. Palæoz., p. 347, 1851.
— YANDELLI, (pars), *ibid.*, p. 344.
— TORTUOSUS, *M'Coy*, British Palæoz. Foss., p. 70, 1851.

Corallum elongate, cylindrico-conical, curved, and slightly tortuous; circular wrinkles well developed and irregular. *Epitheca* strong, and wrinkled transversely. *Calice* suboval, with 4 distinct septal fossulæ, (the one placed near the convex side of the corallum larger and deeper than the three others). *Tabulæ* not very closely set, irregular, and presenting in the centre a large smooth space. *Septa* (30 to 50 in the adult

[1] Milne Edwards and Jules Haime, Pol. Foss. des Terr. Palæoz., p. 318, pl. vii, figs. 1, 2.

individuals) slender, but little developed, not very unequal in size; some rudiments of smaller septa between the former.

The specimens figured in this Monograph (tab. xlix, fig. 5) about 4 inches long, and about $1\frac{1}{2}$ inch wide. Professor M'Coy justly remarks that the specimens described by Mr. Phillips were young individuals, and mentions a gigantic specimen the diameter of which was 1 inch 9 lines.

The specimens here described were found at Torquay and Plymouth, and belong to the collections of Dr. Battersby and Mr. Pengelly. The same species exists at Barton and South Petherwin, according to Mr. Phillips, and at Newton Bushel according to Professor M'Coy.

This species resembles very much *Amplexus Yandelli*,[1] and *A. cornubovis*,[2] but differs from both by the septa being less numerous and almost equal in size, and by the existence of 4 septal fossulæ. *Amplexus coralloides*[3] differs also from *A. tortuosus* by not having the depressions on the tabulæ, and by the circular wrinkles being larger.

2. *Genus* Hallia, (p. lxvii.)

Hallia Pengellyi. Tab. XLIX, figs. 6, 6*a*, 6*b*.

Hallia Pengellyi, *Milne Edwards* and *Jules Haime*, Pol. Foss. des Terr. Pal., p. 354, 1851.

The *calice* of this coral is almost circular, with 54 principal *septa*, which alternate with an equal number of small and thinner ones; the former are very thick, straight, and disposed in a regular radiate manner towards the circumference of the visceral chamber; towards their inner edge they are provided with a large and thin paliform lobe. The cristiform septum is not as large as in *Hallia insignis*,[4] and it is the lobes belonging to the principal septa situated near this that affect a pinnate mode of arrangement. The dissepiments are very slender and closely set. Diameter 1 inch or more; the area occupied by the paliform lobes forms an ellipse of about 9 lines long and 6 lines broad.

Found at Torquay, (Coll. of the Geological Society of London, and of Mr. Pengelly at Torquay). We are inclined to refer to this species some young corals from Pethervin, which are in a very bad state of preservation, and belong to the collection of the Geological Society. They have a strong epitheca.

In *Hallia Pengellyi* the characters of the generic type are not as distinct as in *H. insignis*,[5] the large septum being less developed, and the adjacent septa not assuming as regular a pinnate mode of arrangement; it is also to be remarked that in *H. insignis* all the septa are provided with a very large paliform lobe.

[1] Milne Edwards and Jules Haime, Pol. Foss. des Terr. Palæoz., p. 344. pl. iii, fig. 2, 1851.

[2] Ibid., p. 343, pl. ii, fig. 1.

[3] Tab. xxxvi, fig. 1.

[4] Milne Edwards and Jules Haime, Pol. Foss. des Terr. Palæoz., p. 353, pl. vi, fig. 3, 1851. [5] Ibid.

3. *Genus* Cyathophyllum, (p. lxviii.)

1. Cyathophyllum ceratites. Tab. L, fig. 2.

Cyathophyllum turbinatum, (pars), *Goldfuss*, Petref. Germ., vol. i, p. 50, pl. xvi, figs. 8*c*, *d*, *f*, *g*, *h*, 1826. (Not *Madrepora turbinata*, Linné.)
— ceratites, (pars), *ibid.*, pl. xvii, figs. 1, 2*f*, and perhaps also fig. 5.
— turbinatum, *Holl*, Hanb. der Petref., p. 416, 1830.
— ceratites, *Deshayes*, Coq. cærvet. des Terr., p. 247, pl. xi, fig. 2, 1831.
— turbinatum, *D'Orbigny*, Prodr. de Palæont., t. i, p. 105, 1850.
— ceratites, *Milne Edwards* and *Jules Haime*, Pol. Foss. des Terr. Palæoz., p. 361, 1851.
— — *M'Coy*, Brit. Palæoz. Foss., p. 70, 1851.

Corallum, simple (sometimes two or three individuals are united by their bases, but their union is evidently accidental), turbinate, elongate, slightly curved, and presenting rather well marked growth swellings. *Epitheca* very strong. *Calice* deep and with a thin margin; one or two rudimentary septal fossulæ. *Septa* delicate, alternately larger and smaller but not differing much in size, narrow at their upper end, straight, and not extending quite to the bottom of the central fossula which, as well as the interseptal loculi, is somewhat vesicular. The number of the septa varies, according to the size of the corals, from 60 to 120. The large individuals are sometimes 6 inches wide, with the calice about 3 inches in diameter, and $1\frac{1}{2}$ or two inches deep, but most specimens are not more than two inches in diameter.

Found at Torquay, and according to Prof. M'Coy, at Newton Bushel. In the Eifel Mountains in Germany.

The only British specimen of this species that we have seen is the one figured in this Monograph; it is a young individual in a very indifferent state of preservation.

Cyathophyllum ceratites differs from the other simple species of the same generical group by the depth of its calice, its rudimentary septal fossula, and its septa being almost equally developed.

2. Cyathophyllum Roemeri. Tab. L, fig. 3.

Cyathophyllum dianthus, (pars), *Goldfuss*, Petref. Germ., vol. i, p. 54, tab. xvi, fig. 1*e*, 1826.
— Roemeri, *Milne Edwards* and *Jules Haime*, Pol. Foss. des Terr. Palæoz., p. 362, pl. viii, fig. 3, 1851.

Corallum simple, conical, elongated, curved, and free. *Epitheca* presenting some prominent folds, principally on the side of the convex curve. *Calice* almost circular, large and deep, 74 or more. *Septa* alternately somewhat thicker or thinner, very closely set, not exsert, denticulated, narrow, slightly arched at their upper edge, and extending to

the centre of the visceral chamber, where they become slightly curved. Height 2 inches; diameter somewhat more than 1 inch; depth about 8 lines.

The specimen found at Torquay belongs to Dr. Battersby. This species is also met with at Bensberg and in the Eifel Mountains in Germany.

The type specimen of this species is from the Eifel Mountains, and has only 74 septa. The Torquay fossil that we consider as belonging to the same species, and have figured here, present more than 100 septa; but that difference evidently depends on an accidental multiplication of these laminæ in one part of the septal system where they are more closely set than elsewhere. The species most nearly allied to *C. Roemeri* is *C. Michelini*,[1] but the latter is adherent, its septal fossula is rudimentary, and its septa less closely set.

3. Cyathophyllum obtortum. Tab. XLIX, fig. 7.

Strombodes vermicularis, *Lonsdale*, Trans. of the Geol. Soc. of London, 2d ser., vol. v, pl. lviii, fig. 7, 1840. (Not *Cyathophyllum vermiculare* of Goldfuss.)

— — *Phillips*, Palæoz. Foss., p. 11, pl. vii, fig. 14, 1841.

Cyathophyllum obtortum, *Milne Edwards* and *Jules Haime*, Pol. Foss. des Terr. Palæoz., p. 366, 1851.

Strephodes vermicularis, *M'Coy*, British Palæoz. Foss., p. 73, 1851.

Corallum simple, elongated, subcylindrical. *Calice* circular. Principal *septa* (32 or 34) very thin towards their inner edge and somewhat thicker exteriorly, much curved and twisted near the centre of the calice, and alternating with an equal number of others that are smaller and still thinner. Vesicular dissepiments well developed on the exterior part of the visceral chamber. Height about $2\frac{1}{2}$ inches; diameter of the calice, 1 inch.

Found at Torquay, Plymouth, and Newton Bushel, by Mr. Lonsdale; and at Darlington by Mr. Phillips.

Collections of the Geological Society, and of Prof. Phillips, at York.

This species is very remarkable on account of the septa being so strongly twisted near the centre of the visceral chamber,—a character which distinguishes it easily from *C. Michelini*[2] and *C. Roemeri*[3] that in other respects resemble it very much.

4. Cyathophyllum damnoniense. Tab. L, fig. 1.

Cystiphyllum damnoniense, *Lonsdale*, Geol. Trans., 2d ser., vol. v, p. 703, pl. lviii, fig. 11, 1840.

— — *Phillips*, Palæoz. Foss., p. 9, pl. iv, fig. 11, 1841.

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[1] Milne Edwards and Jules Haime, Pol. Foss. des Terr. Palæoz., p. 366, 1851.

[2] Ibid.

[3] Tab. l, fig. 3.

CYATHOPHYLLUM DAMNONIENSE, *Milne Edwards* and *Jules Haime*, Pol. Foss. des Terr. Palæoz., p. 371, 1851.

CYSTIPHYLLUM — *M'Coy*, Brit. Palæoz. Foss., p. 71, 1851.

Corallum simple, elongate, subturbinate, and almost straight. *Septa* (100 or more) somewhat unequal in size alternately, closely set, very slender exteriorly, thick towards their inner part, and slightly curved. *Dissepiments* very closely set, vesicular, somewhat irregular, smaller and more numerous towards the outer part of the visceral chamber. Some small *tabulæ* somewhat irregular, and very closely set, at the centre of the coral. Height sometimes 3 inches.

Found at Torquay, Newton Bushel, Plymouth, and also, according to Professor Phillips, at Sharkham Point and Babbacombe. Specimens are in the collections of the Geological Society of London, of Dr. Battersby, and Mr. Pengelly.

The fossil Coral designated by the name of CYATHOPHYLLUM CELTICUM,[1] and found in the Devonian deposits of Cornwall and Devonshire,[2] is as yet so imperfectly known that we are not able to characterize it in a satisfactory manner. The specimens met with are only natural casts from which the real coral has more or less completely disappeared; they show, however, that the *septa*, (to the number of 36 or 48), must have been alternately of unequal size, and that the principal ones extended to the centre of the visceral chamber, where they became somewhat twisted.

We have given the name of CYATHOPHYLLUM BUCKLANDI to a species which Professor M'Coy described under that of *Petraia gigas*,[3] but which is quite distinct from the *Cyathophyllum gigas*, previously described in MM. Yandell and Shumard's Paper on the Geology of Kentucky, and therefore could not retain the same name. It is a simple coral like the preceding ones, and is known only by the casts it has left in the surrounding rock. Till some better preserved specimens be met with, we therefore do not think it necessary to have this fossil figured in our Monograph.

[1] *Turbinolia celtica*, Lamouroux, Exp. Meth., p. 85, tab. lxxviii, figs. 7, 8, 1821. *Deslongchamps*, Encycl. (Zooph.), p. 761, 1824; Milne Edwards, 2d edit. of Lamarck, vol. ii, p. 362, 1836. *Petraia celtica*, Lonsdale, Geol. Trans., 2d. ser., vol. v, p. 697, pl. lviii, fig. 6, 1840. *Turbinolopsis celtica*, Phillips, Palæoz. Foss., p. 3, pl. i, fig. 1, 1841. *Cyathophyllum celticum*, D'Orbigny, Prod. de Palæont., vol. i, p. 105, 1850; Milne Edwards and Jules Haime, Pol. Foss. des Terr. Palæoz., p. 373, 1851. *Petraia celtica*, M'Coy, Brit. Palæoz. Foss., p. 74, 1851.

[2] Prof. Phillips mentions this fossil as having been found at South Petherwin, Saint Columb, Pobruan and Fowey in Cornwall; and at Combes, Mudstone Bay, Yealm, Torquay, and Brushford in Devonshire.

[3] *Petraia gigas*, M'Coy, Ann. and Mag. of Nat. Hist., 2d ser., vol. iii, p. 1, 1849; (not *Cyathophyllum gigas*, Yandell and Shumard). *Cyathophyllum Bucklandi*, Milne Edwards and Jules Haime, Pol. Foss. des Terr. Palæoz., p. 390, 1851. *Petraia gigas*, M'Coy, British Palæoz. Foss., p. 74, 1851.

Professor M'Coy describes this fossil in the following terms:—"*Corallum* elongate, conic, gradually increasing, (at an angle from the apex of about 30° externally), slightly oblique; section apparently elliptical, the axes in the proportion of 70 to 100; internal cast obtusely conic, expanding at an angle of about 50° in

The fossils described by Mr. Lonsdale under the name of *Turbinolopsis bina*[1] appear to belong also to the genus Cyathophyllum, but have as yet been found only in the form of casts which are scarcely determinable. They show in general 72 septa of unequal size, alternately denticulated, and slightly curved towards the centre of the visceral chamber. Prof. Phillips mentions the existence of this coral in the Devonian deposits of Combe, near Ashburton.[2]

The corals to which the names of *Turbinolopsis pauciradialis*,[3] *T. elongata*,[4] *T. rugosa*,[5] and *T. pluriradialis*[6] have been given by Prof. Phillips, appear to be specifically identical, or very nearly allied to the preceding species; but the specimens as yet known are so imperfect that we cannot lay before the reader any useful information concerning their structure.

8. Cyathophyllum helianthoides. Tab. LI, figs. 1, 1*a*.

Cyathophyllum helianthoides, *Goldfuss*, Petref. Germ., vol. i, p. 61, tab. xx, fig. 2*a*—*k*' and tab. xxi, fig. 1, 1826.
Favastrea helianthoidea, *De Blainville*, Dict. Sc. Nat., vol. lx, p. 341, 1830.—Man., p. 375.
Turbinolia helianthoides, and Astrea helianthoidea, *Steininger*, Mém. Soc. Géol. de France, vol. i, pp. 344, 345, 1831.
Monticularia areolata, *Ibid.*, p. 346, pl. xx, fig. 10.
Cyathophyllum helianthoides, *Morren*, Descr. Corall. Belg., p. 58, 1832.
— — *Milne Edwards*, 2d edit. of Lamarck, vol. ii, p. 429, 1836.

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compressed specimens, its small end obtuse from the filling up of a considerable length of the base of the coral, by nearly solid sclerenchyme; external walls thick, dense; lamellæ averaging 74 in the adult cups; with the diameter of two and a half inches, the primary ones extending towards the centre, nearly straight for above one third the diameter, then abruptly diminishing in strength, and gradually convoluted spirally towards the broad central area; the secondary lamellæ much finer than the primary, extending about one fifth of the diameter towards the centre; *internal casts* with thirty-three to thirty-seven broad, flattened, smooth ribs, separated by deep smooth-edged sulci (representing the primary lamellæ); these sulci in some specimens, divided by connecting filaments of matrix, produced by perforation in the original plate; each rib divided in the middle by a very fine slit, not reaching quite to the narrow base, (representing the secondary lamellæ,) becoming nearly as strong as the primary towards the broad edge of the cup. No transverse vesicular laminæ. Lengths of imperfect casts about two and a half inches; width of same specimen pressed flat, nearly four and a half inches; width of ribs between the primary sulci at edge of cup varying from two to three lines. Very common in the fine grey Devonian slates of New Quay." (M'Coy, *l. c.*)

[1] *Turbinolopsis bina*, Lonsdale, in Murchison, Silur. Syst., p. 692, pl. xvi bis, fig. 5, 1839. *Turbinolopsis bina*? Ibid., p. 693, pl. xvi bis, fig. 6. *Petraia bina*, M'Coy, Syn. Sil. Foss. of Ireland, p. 60, 1846. *Streptelasmæ bina*, D'Orbigny, Prod. de Pal., vol. i, p. 47, 1850. *Cyathophyllum binum*, Milne Edwards and Jules Haime, Pol. Foss. des Terr. Palæoz., p. 374, 1851.

[2] Palæoz. Foss., p. 4, pl. i, fig. 2.

[3] Phillips, Palæoz. Foss., p. 5, pl. i, fig. 4. From Corffe Quarry, near Tawstock.

[4] Ibid., p. 6, pl. ii, fig. 68. From Horderley, May Hill, and Lickey Hill.

[5] Ibid., p. 7, pl. ii, fig. 7*c*. From Snowdon.

[6] Ibid., pp. 5, 6, pl. ii, figs. 5*a*, 5*β*. From Brushford, Linton, Pilton, and Fowey Harbour.

ASTREA HELIANTHOIDES, *Lonsdale*, Geol. Trans., 2d. ser., vol. v, p. 697, 1840.
DISCOPHYLLUM HELIANTHOIDES, *D'Orbigny*, Prod. de Paléont., vol. i, p. 106, 1850.
CYATHOPHYLLUM HELIANTHOIDES, *Milne Edwards* and *Jules Haime*, Pol. Foss. des Terr. Palæoz., p. 375, pl. viii, fig. 5, 1851.
STREPHODES HELIANTHOIDES, *M'Coy*, Brit. Palæoz. Foss., p. 73, 1851.

Corallum simple or composite.

When simple this species is subturbinate, short, broad, with the edge of the calice reverted, so as to form an obtuse prominent ridge around the central fossula. Sixty or eighty equally-developed *septa*, slightly thickened towards the exterior by the granulations and striæ that arise from their lateral surfaces; almost all of these extend to the centre of the calice, where they become slightly curved, and present, in the well-preserved specimens, small but well-characterised paliform lobes, which, by their agglomeration, form a sort of crown near the centre of the calicular fossula. The edge of the calice is circular and slightly lamellate. The height of the corallum is usually about two inches, and in that case the diameter of the calice is about double, or somewhat more, and that of the paliform circles about four lines.

When composite this corallum assumes an astreiform appearance, and the corallites, which are united together side by side, are circumscribed by polygonal lines, usually not very prominent. The *calices* are in general smaller than in the simple specimens, very unequal in size, and not provided with as many septa. In a variety of this species, the calicular swelling is large and prominent. Vertical sections show that the central part of the visceral chambers is occupied by slightly-developed tabulæ, and the outer parts filled with numerous and somewhat regular vesicles.

Found at Plymouth, Teignmouth Beach, and Mudstone Beach; in France at Viré (Sarthe); in Germany, in the Eifel, Rokeskill, Blankenheim, Steinfeld, Luxembourg, Reinfeld, Sigmaringen; in America, at Harrisville, Ohio, and in the Isle of Mackinaw.

British specimens are in the collections of Mr. J. S. Bowerbank, Dr. Battersby, and Mr. Pengelly.

The species of cyathophyllum that most approximates *C. helianthoides* is *C. Regium*,[1] from the mountain limestone; but in the latter the simple corallites are more regularly turbinate, and the calice is not everted so as to assume the form of a mushroom; the septa are also more numerous and slender.

9. CYATHOPHYLLUM HEXAGONUM. Tab. L, figs. 4, 4*a*.

MADREPORA TRUNCATA? *Esper*, (Pflanz.) Petref., tab. iv; (not Linné).
CYATHOPHYLLUM HEXAGONUM, *Goldfuss*, Petref. Germ., vol. i, p. 61, tab. xx, fig. 1, 1826.
FAVASTREA HEXAGONA, *De Blainville*, Dict. Sc. Nat., vol. lx, p. 340, 1830.—Man., p. 375.
ASTREA HEXAGONA, *Steininger*, Mém. Soc. Géol. de France, vol. i, p. 345, 1831.

[1] Tab. xxxii, figs. 1—4.

CYATHOPHYLLUM HEXAGONUM, *Morren*, Descr. Corall. in Belg. Repert., p. 57, 1832.
— — *Milne Edwards*, 2d edit. of Lamarck, vol. ii, p. 429, 1836.
ASTREA ANANAS, *Ad. Rœmer*, Verst. der Harzegeb., p. 5, tab. ii, fig. 11, 1843.
CYATHOPHYLLUM HEXAGONUM, *Milne Edwards* and *Jules Haime*, Pol. Fos. des Terr. Palæoz., p. 382, 1851.

Corallum composite, astreiform; gemmation calicular and extracalicular. *Calices* polygonal, varying much in size, rather deep, and circumscribed by *walls* that are not very prominent, but quite distinct; thin, and always simple. Forty-six septa, alternately large and small, the twenty-three latter not extending far from the wall; the large ones thin, terminated by a denticulate edge, which is horizontal near the margin, but very strongly arched upwards and inwards, and presenting near the centre of the visceral chamber a small paliform lobe; these lobes form a very distinct crown round the centre of the calice. Height of the corallum about $2\frac{1}{2}$ inches, depth about 2 lines, and diameter of the circle of paliform lobes somewhat more than 1 line.

Found at Torquay; at Montignies, St. Christophe, and Chimay in Belgium; at Bensberg, Refrath, and Grund in Germany.

British specimen in Dr. Battersby's collection.

This species differs from *C. quadrigeminum*[1] by its calices being larger and shallower, and by the paliform lobes of the septa; it differs from *C. cæspitosum*[2] by these lobes being larger than in the latter and the septa more equally developed. In *C. boloniense*[3] the calices are larger, the septa less prominent and more developed, and the paliform lobes are quite rudimentary. In *C. marmini*[4] the calices are deep and the septa rather unequal. In *C. Sedgwicki*[5] the septa are less numerous than in the above-described species, and become thicker towards three fourths of their breadth.

10. CYATHOPHYLLUM CÆSPITOSUM. Tab. LI, figs. 2, 2*a*, 2*b*.

CYATHOPHYLLUM CÆSPITOSUM, *Golfuss*, Petref. Germ., vol. i, p. 60, tab. xix, fig. 2, 1826.
— HEXAGONUM (pars.), *Ibid.*, tab. xix, fig. 5*a*, *b*, *c*. (Cœt. excl.)
CARYOPHYLLIA DUBIA, *De Blainville*, Dict. Sc. Nat., vol. lx, p. 311, 1830.—Man., p. 345.
CYATHOPHYLLUM CÆSPITOSUM, *Milne Edwards*, 2d edit. of Lamarck, vol. ii, p. 428, 1836.
— — *Lonsdale*, Geol. Trans., 2d ser., vol. v, 3d part, pl. lviii, fig. 8, 1840.
— — *Phillips*, Palæoz. Foss., p. 9, pl. 3, fig. 10, 1841.
CLADOCORA GOLDFUSSI, *Geinitz*, Grundr. der Verst., p. 569, 1845-46.
DIPHYPHYLLUM CÆSPITOSUM, *D'Orbigny*, Prod. de Paléont., vol. i, p. 106, 1850.
CYATHOPHYLLUM — *Milne Edwards* and *Jules Haime*, Pol. Foss. des Terr. Palæoz., p. 384, 1851.
— — *M'Coy*, British Palæoz. Foss., p. 69, 1851.

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[1] Goldfuss, Petref. Germ., t. i, p. 59, tab. xix, figs. 1, 5*f*, and tab. xviii, fig. 6, 1826.
Tab. li, fig. 2. [3] Tab. lii, fig. 1. [4] Tab. lii, fig. 4. [5] Tab. lii, fig. 3.

Corallum composite, fasciculated, or astreiform; tall; gemmations principally calicular. *Corallites* almost cylindrical, and presenting but slight growth swellings. *Calices* in general circular, sometimes agglomerated and polygonal; rather deep. Forty or fifty *septa*, somewhat unequal in size alternately, thin, narrow at the top, straight, and bearing a small paliform lobe near the centre of the calice. Diameter of the calices about 4 lines. *Tabulæ* well developed; interseptal vesicles small. In horizontal sections of this corallum the spot where the dissepiments cease has the appearance of an inner wall, placed at a small distance from the exterior one.

Found at Teignmouth Beach near Torquay, at Newton, and at Plymouth.

Specimens are in the collections of Mr. Bowerbank and of Dr. Battersby.

In a variety of this species found at Torquay, the calices are not more than 2 or $2\frac{1}{2}$ lines in diameter.

M. D'Orbigny has placed this coral in the genus *Diphyphyllum* of Mr. Lonsdale. As Professor M'Coy very justly remarks, some specimens appear so distinctly dichotomous that they evidently belong to this division, whereas in other specimens the gemmation is quite lateral, as in the common Cyathophylla.[1]

This species resembles *C. marmini*[2] by its general arrangement, being in some specimens fasciculate and in others astreiform; but in the latter fossil the calices are deeper, and the septa are not only less unequal, but also produce at their upper edge the appearance of an inner wall. The same variations in the general form of the composite corallum is sometimes met with also in *C. quadrigeminum*,[3] which, however, differs from *C. cæspitosum* by the septa being still more slender, and not bearing any paliform lobes.

11. Cyathophyllum boloniense. Tab. LII, figs. 1, 1*a*.

Montastrea boloniensis, *Blainville*, Dict. Sc. Nat., vol. lx, p. 339, 1830.—Man., p. 394.
Cyathophyllum hexagonum, *Michelin*, Icon. Zooph., p. 181, pl. xlvii, fig. 2, 1845. (Not *Goldfuss.*)
Lithostrotion arachnoides, *D'Orbigny*, Prod. de Paléont., t. i, p. 106, 1850. (Not *Astrea arachnoides*, de France.)
Cyathophyllum boloniense, *Milne Edwards* and *Jules Haime*, Pol. Foss. des Terr. Palæoz., p. 385, pl. 9, fig. 1, 1851.

Corallum composite, astreiform, forming a subcircular rather flat mass. *Calices* polygonal, very unequal in size, deep, and separated by thin, straight walls. Forty-two or forty-six *septa*, almost equal in size, very slender, striated laterally, delicately denticulated, and straight; half of them do not extend quite to the centre of the calice, the other

[1] It is surprising that after having recognized these variations the latter author should not have come to a similar result respecting the Diphyphyllum of the carboniferous formation which bear the same relation to Lithostrotions.

[2] Milne Edwards and Jules Haime, Pol. Foss. des Terr. Palæozoiques, p. 386, pl. ix, figs. 2, 3, 1851.

[3] Goldfuss, Petref. Germ., t. i, p. 59, tab. xix, figs. 1, 5*f*, and tab. xviii, fig. 6, 1826.

advance a little more, and present a very small paliform lobe, which is in general rather indistinct. All the septa are broad, and their upper edge is somewhat oblique till at some distance from the wall, but becomes slightly convex further inwards. Diagonal of the large calices about 8 lines.

Found at Ogwell, Torquay; and at Ferques near Boulogne.

In the collection of Dr. Battersby, &c.

This species is very closely allied to *Cythophyllum hexagonum*,[1] but its septa are more similar in size, less prominent at a small distance from the walls, and have much smaller paliform lobes. It bears also great resemblance to *C. Sedgwicki*,[2] which differs from it principally by the septa becoming thicker at a small distance from the centre of the calice. *C. Davidsoni*[3] presents also the same aspect, but has the calices much smaller, and the septa smaller and less numerous.

12. Cyathophyllum marmini. Tab. LII, figs. 4, 4*a*.

Cyathophyllum profundum, *Michelin*, Icon. Zooph., p. 184, pl. xlviii, fig. 1, 1849. (Not Geinitz.)

— cæspitosum, *Ibid.*, p. 184, pl. xlvii, fig. 5. (Not Goldfuss.)

Lithostrotion profundum, *D'Orbigny*, Prod. de Pal., vol. i, p. 106, 1850.

Cyathophyllum marmini, *Milne Edwards* and *Jules Haime*, Pol. Foss. des Terr. Palæoz., p. 386, pl. ix, figs. 2, 3, 1851.

Corallum composite, subfasciculate or astreiform; gemmation almost always lateral. *Corallites* very unequal in size, circular when free laterally, polygonal when aggregated. *Calice* deep and broad. About 40 *septa*, more or less similar among themselves, thin, delicately denticulated, and extending for the most part to the bottom of the calicular cavity, where they present only rudimentary paliform lobes; at a short distance from the wall they are somewhat prominent, and assume there the appearance of an interior wall. Dissepiments numerous. Diameter of the calices 4 or 5 lines; depth about $2\frac{1}{2}$.

Found at Teignmouth and Torquay. (Collection of Dr. Battersby.)

This species differs from *C. cæspitosum*[4] by its calice being deeper, its septa less unequal, and more especially by its mode of gemmation, which is almost always lateral; and from *C. quadrigeminum*[5] by the septa being less regular and the existence of paliform lobes, which are absent in the latter species.

10. Cyathophyllum Sedgwicki. Tab. LII, figs. 3, 3*a*.

Cyathophyllum Sedgwicki, *Milne Edwards* and *Jules Haime*, Pol. Foss. des Terr. Palæoz., p. 387, 1851.

[1] Tab. l, fig. 4. [2] Tab. lii, fig. 1.

[3] Milne Edwards and Jules Haime, Pol. Foss. des Terr. Palæoz., p. 389. [4] Tab. li, fig. 2.

[5] Goldfuss, Petref. Germ., tab. i, p. 59, tab. xix, figs. 1, 5*f*, and tab. xviii, fig. 6, 1826.

Corallum composite, astreiform. *Calices* unequal in size, polygonal, and separated by nearly straight walls. Gemmation calicular as well as lateral. *Septa* (32 or 40) well developed, somewhat unequal in size; the smaller ones thin all along, the larger ones thin outwardly, but becoming thicker at about two thirds of their breadth, and again thin towards the centre of the calice, where they are slightly curved, and present a very small paliform lobe. The vesicular *dissepiments* are mostly small, but are rather unequal in size, and do not extend beyond the middle of the thick part of the principal septa. Great diagonal of the calices usually about 6 lines; diameter of the circle of paliform lobes about two thirds of a line.

Found at Babbacombe Beach, Torquay. (Collections of Mr. Bowerbank and Dr. Battersby.)

This species is intermediate between *C. hexagonum*[1] and *C. boloniense*,[2] but approximates most to the latter, from which it differs principally by the thickness of the principal septa at a small distance from the centre of the calice.

14. Cyathophyllum æquiseptatum. Tab. LII, fig. 1.

Cyathophyllum æquiseptatum, *Milne Edwards* and *Jules Haime*, Pol. Foss. des Terr. Palæoz., p. 389, 1851.

Corallum composite, fasciculate. *Corallites* distant from each other, multiplying by lateral gemmation, surrounded by an epitheca, and appearing subcylindrical. *Calices* deep, and with a thin edge. *Septa* (about 36) very narrow upwards, not remarkably thin, and almost equal in size. Diameter of the corallites about 4 lines.

Found at Ilfracombe in Devonshire.

In the Collection of the Geological Society.

This species is remarkable for the equal development of all the septa.

We are inclined to consider the *Strephodes gracilis*[3] of Prof. M'Coy as belonging to the genus Cyathophyllum, but it may be a species of *Ptychophyllum*.

[1] Tab. l, fig. 4. [2] Tab. lii, fig. 1.

[3] *Strephodes gracilis*, M'Coy, Ann. and Mag. of Nat. Hist., 2d ser., vol. vi, p. 378, 1850; M'Coy, Brit. Palæoz. Foss., p. 72, 1851.

Professor M'Coy describes this fossil in the following terms:—"*Corallum* simple, very gradually tapering, irregularly twisted, averaging three inches long, and eight lines in adult diameter; *horizontal section*, outer wall very thick, solid; radiating lamellæ at the above diameter about 56, very thin, extending in a slightly irregular manner towards a large central space, which the primary ones fill with their irregular complicated extremities; secondary lamellæ as thick as the primary, of irregular lengths, but seldom extending one fourth the distance to the centre; transverse vesicular plates extremely delicate, rather few, irregular; vertical section showing in the middle a few irregularly flexuous delicate longitudinal lines (edges of the complicated ends of the vertical radiating lamellæ); sides occupied by very open vesicular tissue, composed of large, curved, delicate, oblique plates, forming about two rows of great cells on each side; outer wall very thick, forming a nearly smooth surface; when decorticated, the lamellar sulci average 5 in 2 lines; terminal cup deep, strongly radiated to the flattened centre. Locality; Newton Bushel."

4. *Genus* Endophyllum.[1]

1. Endophyllum Bowerbanki. Tab. LIII, fig. 1.

Endophyllum Bowerbanki, *Milne Edwards* and *Jules Haime*, Pol. Foss. des Ter. Palæoz., p. 394, 1851.

Corallum composite, astreiform. *Corallites* more or less intimately united together by rudimentary exterior walls and an irregular vesicular tissue. Inner *walls* well constituted, circular, and often double. Principal *septa* (30 or 32) pretty well developed, rather slender, very flexuous inwardly, extending almost to the centre of the calice, and alternating with an equal number of smaller septa. They do not project much outside the wall, so as to form costal striæ, that soon disappear in the vesicular tissue. *Tabulæ* well developed and somewhat irregular. Diameter of the mural circles about 8 lines, distance between them 5 or 7 lines.

Found at Barton near Torquay.

In the Collections of Mr. Bowerbank, Dr. Battersby, &c.

The Genus Endophyllum has been established since the publication of the Introduction to this Monograph, and is intermediate between *Cyathophyllum* and *Acervularia*, having most of the structural characters of the first, but presenting completely vesicular tissue exteriorly to well-defined walls. In Acervularia there is a well-developed epitheca, which does not exist in Endophyllum, and the septal system is much more developed in the space between the two mural investments.

Endophyllum Bowerbanki differs from *E. abditum*[2] by its outer walls being rudimentary, its inner walls being well constituted, and its septa thicker though still rather slender.

2. Endophyllum abditum. Tab. LII, fig. 6.

Endophyllum abditum, *Milne Edwards* and *Jules Haime*, Pol. Foss. des Terr. Palæoz., p. 394, 1851.

Corallites more or less closely united by polygonal walls, which are rather strong. Inner walls thin, often double and rather irregularly circumscribed. The space comprised between the two walls is filled with large vesicles, on which some costal striæ may be recognised. Principal *septa* (34 to 40) very slender, especially inwardly, where they become much curved, an equal number of smaller septa alternating with the principal ones. Diagonal of the large calices almost 2 inches; diameter of the mural circle about 12 lines.

[1] Milne Edwards and Jules Haime, Pol. Foss. des Terr. Palæoz.; Archives du Muséum, vol. v, p. 393, 1851.

[2] Tab. lii, fig. 6.

Found at Teignmouth Beach by Dr. Battersby.

This fossil differs from *E. Bowerbanki*[1] by its well-developed outer wall and its very slender septa.

5. *Genus* Campophyllum, (p. lxviii.)

The fossil described by Mr. Phillips under the name of *Cyathophyllum turbinatum*,[2] and found by that able geologist at Babbacomb, appears to be specifically identical with Goldfuss's *Cyathophyllum flexuosum*,[3] a coral, appertaining to our genus *Campophyllum*;[4] but we have seen as yet no British specimen of this species.

6. *Genus* Pachyphyllum, (p. lxviii.)

Pachyphyllum Devoniense. Tab. LII, figs. 5, 5*a*.

Pachyphyllum Devoniense, *Milne Edwards* and *Jules Haime*, Pol. Foss. des Terr. Palæoz., p. 397, 1851.

This species is known to us only from a polished slab, communicated to us by Dr. Battersby, but appears to be sufficiently characterised to authorise its admission in a methodical arrangement of the Devonian corals.

The *corallites* are not circumscribed, but their radii are not completely confluent. The exterior portion of each individual is principally formed by a vesicular tissue, through which well-defined but very slightly constituted costæ extend. At some distance from the centre of each corallite, a well-marked subcircular or elliptical zone is formed by a slight enlargement of the septa, and appears to represent a rudimentary wall. *Septa* (44 or 48) very slender, unequally developed alternately, the larger ones very slender inwardly, where they become somewhat flexuous and appear to have a paliform lobe, and extending only to a short distance from the centre of the calice. Breadth of the corallites about 8 lines; diameter of the mural zones about 4 lines.

Found at Torquay by Dr. Battersby.

This species differs from *P. Bouchardi*[5] by its septa being more numerous, more slender and unequal, and by the principal ones bearing a small paliform lobe.

[1] Tab. liii, fig. 1.

[2] Palæoz. Fossils, p. 8, pl. vii, fig. 9.

[3] Petref. Germ., vol. i, p. 57, tab. xvii, figs. 3*a*, 8.

[4] *Campophyllum flexuosum*, Milne Edwards and Jules Haime, Monogr. des Polyp. des Terr. Palæoz., p. 395, pl. viii, fig. 4.

[5] Milne Edwards and Jules Haime, Pol. Foss. des Terr. Palæoz., p. 397, pl. vii, fig. 7, 1851.

7. *Genus* Chonophyllum, (p. lxix).

Chonophyllum perfoliatum. Tab. L, fig. 5.

Cyathophyllum plicatum, *Goldfuss*, Petref. Germ., vol. i, p. 59, tab. xviii, fig. 5, 1826. (Not tab. xv, fig. 12.)
— — *Milne Edwards*, 2d edit. of Lamarck, vol. ii, p. 431, 1836.
— perfoliatum, *Goldfuss*, MSS. in Bonn Museum.
Chonophyllum perfoliatum, *Milne Edwards* and *Jules Haime*, Pol. Foss. des Terr. Palæoz., p. 405, 1851.

Corallum simple, straight, rather elongate. *Calice* not remarkably deep, and of a subconical form. *Septa* (60 to 74) equally developed, straight, and extending almost to the centre of the corallum. Some vestiges of a rudimentary septal fossula are visible. Height about 3 inches, diameter about 2 inches.

Found at Torquay. (Collection of Dr. Battersby.)

A fossil found at Wenlock, and belonging to the collection of M. D'Archiac, appears to belong also to this species.

C. perfoliatum differs from *C. elongatum*[1] by its general form being broader and less elongate, and by its tabulæ being less infundibuliform.

8. *Genus* Heliophyllum, (p. lxix.)

Heliophyllum Halli. Tab. LI, fig. 3.

Strombodes helianthoides, *Phillips*, Fig. and Descr. of Palæoz. Foss., p. 10, pl. v, fig. 13*a*, 1841. (Not *Cyathophyllum helianthoides*, Goldfuss.)
— — *Hall*, Geol. of New York, 4th part, p. 209, No. 48, fig. 3, 1843.
Cyathophyllum turbinatum, *Ibid.*, No. 49, fig. 1. (Not Goldfuss.)
— — *Castlenau*, Ter. sil. de l'Amer. du Nord., pl. xvi, fig. 5, 1843.
Heliophyllum Halli, *Milne Edwards* and *Jules Haime*, Brit. Foss. Corals, Introd., p. lxix, 1850.
— — *Milne Edwards* and *Jules Haime*, Pol. Foss. des Terr. Palæoz., p. 408, pl. vii, fig. 6, 1851.

Corallum simple, turbinate, or cylindro-conical, usually elongate, and slightly curved at its base, provided with an epitheca, and presenting slight circular swellings. *Calice*

[1] Milne Edwards and Jules Haime, Polyp. Foss. des Terr. Palæoz., p. 406, pl. viii, fig. 1, 1851.

circular, rather deep, with a small septal fossula. *Septa* (80 or even more) very thin, closely set, rather broad at their upper end, where they are arched and denticulate, alternately larger and smaller, slightly twisted near the centre of the visceral chamber. A vertical section shows that the lateral processes of the septa are arched and ascendant; those situated towards the upper end of the corallum terminate at the edge of the septa; those situated lower down unite near the centre of the visceral chamber, so as to constitute irregular *tabulæ*. The interseptal loculi are filled up with these lamellate processes, which are situated at about half a line apart, and united by closely-set simple dissepiments that form right angles with them. Diameter of the calice from 1 to 2 inches.

The specimen submitted to our investigation was found at Torquay. Prof. Phillips has also met with this fossil at Plymouth, Babbacombe, and Sharkham Point. The same species is found in North America.

9. *Genus* Acervularia, (p. lxx).

1. Acervularia Goldfussi. Tab. LIII, figs. 3, 3*a*.

Cyathophyllum ananas, *Goldfuss*, Petref., vol. i, p. 60, pl. xix, fig. 4*a*, 1826. (Not fig. 4*b*.)
— — *Hall*, Handb. der Petref., p. 416, 1830.
— — *Morren*, Descr. Corall. in Belgio Repert., p. 56, 1832.
— — *Milne Edwards*, 2d edit. of Lamarck, vol. ii, p. 429, 1836.
Astrea basaltiformis, *Ad. Roemer*, Verst. des Harzgeb., p. 5, tab. ii, fig. 12, 1843.
Acervularia Goldfussi, *De Verneuil* and *Jules Haime*, Bull. Soc. Géol. de France, 2d ser., vol. vii, p. 161, 1850.
Lithostrotion ananas, (pars), *D'Orbigny*, Prod. de Paléont., vol. i, p. 106, 1850.
Acervularia Goldfussi, *Milne Edwards* and *Jules Haime*, Pol. Foss. des Terr. Palæoz., p. 417, 1851.

Corallum composite, massive, astreiform; the polygonal lines on its surface well marked and rather zigzagged. Great diagonal of the corallites about 3 lines. The inner wall well constituted, rather strong, with the septa somewhat exsert, and being only about 1 line in diameter. *Septa* (24 or 26) almost straight, very slender, and extending alternately more or less towards the centre. *Dissepiments* rather closely set.

Found at Torquay, by Dr. Battersby.

This species much resembles *A. coronata*[1] by the development of its inner and outer walls, but differs from it by the septa being somewhat unequal in size. The costo-septal radii are still more similar and closer set in *A. pentagona*,[2] the corallites of which are also much smaller. In *A. Roemeri*[3] these radii are very slender, and flexuous outwardly, and the outer walls are very vaguely indicated.

[1] Tab. liii, fig. 4. [2] Tab. liii, fig. 5. [3] Tab. liv, fig. 3.

2. Acervularia coronata. Tab. LIII, figs. 4, 4*a*, 4*b*.

Acervularia coronata, *Milne Edwards* and *Jules Haime*, Pol. Foss. des Terr. Palæoz., p. 416, 1850.

A polished section of this coral shows that the corallites are united by means of well-defined polygonal epithecal walls. The inner walls are also well constituted, and circumscribe a very small area comparatively to the breadth of the corallites. *Septa* (generally 28) very slender, somewhat thickened by lateral granulations near the outer wall, where most of them become slightly curved. In the space comprised between the two mural investments the septa are equally developed; but only one half of them penetrate into the visceral chamber, and extend almost to the centre of the corallite, where they bear a small but well-defined paliform lobe. *Exothecal dissepiments* very closely set. Diagonal of the corallites 5 or 6 lines.

Found at Barton near Torquay.

In the Collections of Dr. Battersby and Mr. Pengelly.

This species, by the development of its two mural investments, differs from *A. intercellulosa*[1] and *A. limitata*,[2] in which the inner wall is only indicated by a slight thickening of the septa; and from *A. Battersbyi*,[3] in which the exterior wall is rudimentary. In *A. Roemeri*[4] the septa are much more slender, and more curved outwardly. In *A. pentagona*[5] and *A. Goldfussi*,[6] the septa all reach very near to the centre of the visceral chamber, whereas in the above-described coral half of them do not extend beyond the inner walls.

3. Acervularia intercellulosa. Tab. LIII, figs. 2, 2*a*.

Astrea intercellulosa, *Phillips*, Palæoz. Foss. of Cornwall, &c., p. 12, pl. vi, fig. 17, 1841.
Favastrea — *D'Orbigny*, Prod. de Paléont., vol. i, p. 107, 1850.
Acervularia — *Milne Edwards* and *Jules Haime*, Pol. Foss. des Terr. Palæoz., p. 417, 1851.

Corallites polygonal, unequal in size, circumscribed by well-marked zigzagged exterior walls. *Inner walls* rendered distinct by a thickening of the septa, and forming circles which are very large in proportion to the size of the polygones. *Septa* (40 to 44) slightly developed in the exterior parts of the corallites, where they become quite lost in the vesicular tissue; in the part corresponding to the inner wall they are thick, but they become slender again more inwardly, where one half of them reach almost to the centre of the corallite, and are provided with a paliform lobe. Great diagonal of the polygonal corallites about 6 lines; diameter of the calice about 4 lines.

[1] Tab. liii, fig. 2. [2] Tab. liv, fig. 1. [3] Tab. liv, fig. 2.
[4] Tab. liv, fig. 3. [5] Tab. liii, fig. 5. [6] Tab. liii, fig. 3.

Found at Torquay.

In the Collections of Dr. Battersby and Mr. Pengelly.

This species resembles *A. limitata*[1] in having the inner wall rudimentary, and indicated only by a thickening of the septa; it differs from it, as well as from the other Acervularia, by the great number of the septa.

4. Acervularia pentagona. Tab. LIII, figs. 5, 5*a*, 5*b*.

Cyathophyllum pentagonum, *Goldfuss*, Petref. Germ., vol. i, p. 60, tab. xix, fig. 3, 1826.
Favastrea pentagona, *De Blainville*, Dict. Sc. Nat., vol. lx, p. 340, 1830.—Man., p. 375.
Cyathophyllum pentagonum, *Morren*, Desc. Corall. Belg., p. 56, 1832.
— — *Milne Edwards*, 2d ed. of Lamarck, vol. ii, p. 430, 1836.
Astrea pentagona, *Lonsdale*, Geol. Trans., 2d ser., vol. v, pl. 57, fig. 1, 1840. (Not fig. 1*a*.)
— — *Phillips*, Palæoz. Foss., p. 11, pl. vi, fig. 15, 1841.
Acervularia pentagona, *Michelin*, Icon., p. 180, pl. xlix, fig. 1, 1845.
— ananas, *Ibid.*, p. 180, pl. xlvii, fig. 1.
Lithostrotion pentagonum, *D'Orbigny*, Prod., vol. i, p. 106, 1850.
Acervularia pentagona, *Milne Edwards* and *Jules Haime*, Pol. Foss. des Terr. Palæoz., p. 418, 1851.
— — *M'Coy*, Brit. Palæoz. Foss., p. 91, 1851.

Corallum forming an astreiform mass. *Corallites* somewhat unequal in size, polygonal, their great diagonal measuring in general about 2 lines, and the diameter of the inner walls about half a line. *Septa* (18 to 24) subequal, slender, and almost straight. The lines of demarcation between the corallites slightly zigzagged.

Found at Torquay and at Ogwell. Prof. Phillips mentions having met with this species at Newton Bushel, Sharkham Point, and Babbacombe. It is found also in the Eifel, and in the province of Limbourg.

In the Collections of Messrs. Bowerbank and Pengelly.

This is the smallest species of Acervularia known, and that in which the septa are the least numerous. *A. coronata*,[2] to which it bears most resemblance, differs from it by the great inequality of the septa.

5. Acervularia limitata. Tab. LIV, fig. 1.

Astrea pentagona (pars), *Lonsdale*, Geol. Trans., 2d ser., vol. v, pl. lviii, fig. 1*a*, 1840. (Not fig. 1.)
Acervularia limitata, *Milne Edwards* and *Jules Haime*, Pol. Foss. des Terr. Palæoz., p. 419, 1851.

A polished slab of this coral shows that the corallites are circumscribed by well-marked zigzagged polgyonal lines. The inner walls are, on the contrary, but slightly marked,

[1] Tab. liv, fig. 1.

[2] Tab. liii, fig. 4.

and are principally indicated by a small thickening of the septa. In general 26 *septa*, rather slender, granulated on the sides, and often slightly curved in the space comprised between the two mural investments; half of them do not extend further than the inner wall, and those which penetrate into the central area do not appear to have any paliform lobes. Diagonal of the corallites 3 lines; diameter of the inner walls 1 line.

Found in Newton Quarry near Torquay.

In the Collections of the Geological Society and Dr. Battersby.

In this species the inner wall is rudimentary, as in *A. intercellulosa*,[1] but the septa are less numerous, and do not give rise to paliform processes.

6. Acervularia Battersbyi. Tab. LIV, fig. 2.

Acervularia Battersbyi, *Milne Edwards* and *Jules Haime*, Pol. Foss. des Terr. Palæoz., p. 419, 1851.

A horizontal section of this species shows that the Corallites are very closely united together and limited only by a very thin exterior wall, which form zigzags, is slightly marked, and constitutes polygonal divisions. The *inner walls* are, on the contrary, very thick, and circumscribe a central area, which is very small in proportion to the space occupied by the whole of each Corallite; they appear to be composed of a dense exothecal tissue. *Septa* (36), of equal size in the outer area, very slender, for the most part much curved, almost confluent, and slightly thickened, where enclosed in the inner wall; half of them extend almost to the centre of the visceral chamber, where they present a small paliform lobe. *Dissepiments* very abundant and closely set in the exterior area, but almost completely absent in the inner area. Great diagonal of the Corallites 6 or 8 lines; diameter of the calices 2 lines, or somewhat more.

Found at Torquay and at Newton.

In the Collections of the Geological Society and Dr. Battersby.

This species, by the feeble development of the outer walls and its subconfluent septa, leads to the genus *Phillipsastrea*. It differs from *A. Roemeri*, where the exterior wall is also but slightly developed, by the septa being more numerous and provided with a paliform lobe.

7. Acervularia Roemeri. Tab. LIV, fig. 3.

Astrea Hennahii, *Ad. Roemer*, Verst. des Harzgebirges, p. 5, tab. ii, fig. 13, 1843. (Not Lonsdale.)

— parallela ? *Ibid.*, tab. iii, fig. 1.

Phillipsastrea parallela ? *D'Orbigny*, Prod. de Paléont., vol. i, p. 107, 1850.

[1] Tab. liii, fig. 2.

Acervularia Roemeri, *De Verneuil* and *Jules Haime*, Bull. Soc. Géol. de France, 2d ser., vol. vii, p. 162, 1850.

— — *Milne Edwards* and *Jules Haime*, Polyp. Foss. des Terr. Palæoz., p. 420, 1851.

Corallum massive with an almost flat surface. *Corallites* prismatic, and intimately united together. Outer walls very slender, and often difficultly recognised in certain states of fossilization. Great diagonal of the Corallites 2 or 3 lines or more; diameter of the inner walls less than 1 line. 26 or 28 septa costal laminæ, very slender, and strongly curved or flexuous towards the centre of the Corallites.

Found at Torquay; at Grund in the Hartz; and at Puerto de las Volcas near Pola de Gordon, in the province of Leon in Spain.

In the Collection of Dr. Battersby.

Professor M'Coy mentions this species as having been met with also at Barton and Teignmouth; but he does not distinguish it from *Acervularia intercellulosa*.

This species differs from all the other Acervulariæ by its septa being much curved, and its outer walls rudimentary. *A. Battersbyi*[1] has the septa more numerous, more slender, and provided with a paliform lobe.

10. *Genus* Smithia.[1]

1. Smithia Hennahii. Tab. LIV, fig. 4.

Astrea Hennahii (pars), *Lonsdale*, in Sedgwick and Murchison, Geol. Trans., 3d ser., vol. v, p. 697, pl. lviii, fig. 3, 1840.

— — *Phillips*, Palæoz. Foss., p. 12, pl. vi, fig. 16, 1841.

Cyathophyllum Hennahii, *Bronn*, Index Paléont., vol. i, p. 368, 1848.

Lithostrotion Hennahii, Actinocyathus Hennahii, and Phillipsastrea Hennahii (pars), *D'Orbigny*, Prod. de Paléont., vol. i, pp. 106, 107, 1850.

Smithia Hennahii, *Milne Edwards* and *Jules Haime*, Polyp. Foss. des Terr. Pal., p. 421, 1851.

Arachnophyllum Hennahii, *M'Coy*, Brit. Palæoz. Foss., p. 72, 1851.

A polished horizontal section of this compound astreiform corallum shows that the *mural circles*, although slender, are well characterised, and placed at a distance from each other, equal to 2, 3, or even 4 times their diameter, but varying sometimes very much in the same specimen. *Costal radii* (24 or 26 in a corallite) slender, appearing to be slightly granulated on their sides, and in general much more developed, more confluent and straighter in one direction than in the other, where they become irregular, flexuous, angular or geniculate; half of the radii do not extend beyond the wall; the others become somewhat thicker at that part, and pass on towards the centre of the visceral chamber, where some traces of small paliform lobes are seen. Diameter of the mural circles about $1\frac{1}{2}$ line.

[1] Tab. liv, fig. 2.

[2] Milne Edwards and Jules Haime, Pol. Foss. des Terr. Palæoz., p 421, 1851.

A vertical section shows that the intercostal loculi are filled up with vesicles, which are very small and pretty regular. The *dissepiments* of the interseptal loculi are almost horizontal, and unite at the centre of the visceral chamber so as to form a series of small and very closely set *tabulæ*.

Found at Torquay, Plymouth, and Newton.

In the Collections of Mr. Bowerbank, Dr. Battersby, and Mr. Pengelly.

S. Pengelli[1] differs from the above-described species by its septa being more numerous and its walls rudimentary.

In *S. Bowerbanki*[2] the septa are less numerous and more vermiculate.

In *S. Boloniensis*[3] the calices are smaller, and costal radii completely confluent.

2. Smithia Pengellyi. Tab. LV, fig. 1.

Astrea hennahii, (pars), *Lonsdale*, in Sedgwick and Murchison, Geol. Trans., 2d ser., vol. v, 3d part, p. 697, pl. lviii, fig. 3*a*, 1840.

Smithia Pengellyi, *Milne Edwards* and *Jules Haime*, Pol. Foss. des Terr. Pal., p. 422, 1851.

Mural circles not very distinct, and indicated principally by a slight thickening of the septa, which are placed at very unequal distances. *Costal radii* (not more than 40) alternately unequal in thickness, granulated laterally; in general larger and more confluent in one direction than in the other, where they are flexuous and even angular; half of them do not extend further than the wall; the others become somewhat thicker on that part, and, passing on, become very slender towards the centre of the visceral chamber, where they bear paliform appendices. Diameter of the mural circle 2 lines, or somewhat more. *Dissepiments* very closely set.

Found at Torquay and Plymouth.

In the Collections of the Geological Society, Mr. Bowerbank, Dr. Battersby, and Mr. Pengelly.

This species differs from the preceding one by its septa being more numerous, thicker, and closer set. It is also well characterised by its walls being rudimentary.

3. Smithia Bowerbanki. Tab. LV, fig. 2.

Smithia Bowerbanki, *Milne Edwards* and *Jules Haime*, Pol. Foss. des Terr. Palæoz., p. 423, 1851.

Mural circles well developed, and placed very widely apart, but at unequal distances. *Costal radii* (18 or 20) completely confluent, slender, larger, and straighter in one direction than in the other, but in general flexuous and vermiculate (the more so as they

[1] Tab. lv, fig. 1.

[2] Tab. lv, fig. 2.

[3] Milne Edwards and Jules Haime, Pol. Foss. des Terr. Palaeoz., p. 423, 1851.

extend farther from the calice), becoming somewhat thicker in the wall, where they also become unequal in size; the larger ones do not appear to extend quite to the centre of the visceral chamber, and show no traces of paliform lobes. *Dissepiments* very small. Diameter of the wall about two thirds of a line.

Found at Torquay by Dr. Battersby.

This corallum differs from all the other species of the same genus by the small dimensions of the calices and the considerable distance between them; it is also remarkable for the complete confluency of its costal radii.

11. *Genus* Spongophyllum.[1]

Spongophyllum Sedgwicki. Tab. LVI, figs. 2, 2*a*, 2*b*, 2*c*, 2*d*, 2*e*.

Spongophyllum Sedgwicki, *Milne Edwards* and *Jules Haime*, Pol. Foss. des Terr. Pal., p. 425, 1851.

Corallum composite, massive, astreiform. *Calices* polygonal, very unequal in size, and circumscribed by pretty strong walls. No *columella*. *Septal radii* (14 or 16) extremely slender, extending in general to a short distance from the centre of the visceral chamber, slightly flexuous, and often not very distinct in the midst of the vesicular tissue that fills the cavity of the corallites. These septa alternate with an equal number of rudimentary ones.

A vertical section shows that the outer parts of the visceral chambers are occupied by vesicles unequal in size, in general much elongated and rather irregular, but that in the centre there are small horizontal tabulæ. Diagonal of the large calices $2\frac{1}{2}$ or 3 lines.

Found at Torquay.

In the Collection of Dr. Battersby.

This fossil is the only known species of our genus *Spongophyllum*, which is characterized principally by the rudimentary state of the radial laminæ; these appear to form slight ridges on the surface of the vesicles, but not to pass through them, and resemble the costal system of the corals forming the genus *Lonsdalia*.

12. *Genus* Syringophyllum, (p. lxxii.)

Syringophyllum Cantabricum. Tab. LV, fig. 3.

Phillipsastrea Cantabrica, *De Verneuil* and *Jules Haime*, Bull. Soc. Géol. de France, 2d ser., vol. vii, p. 162, 1850.

Syringophyllum? Cantabricum, *Milne Edwards* and *Jules Haime*, Pol. Foss. des Terr. Palæoz., p. 451, 1851.

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[1] Milne Edwards and Jules Haime, Pol. Foss des Terr. Palæoz.; Archives du Muséum, vol. v, p. 425, 1851.

Corallum composite, forming almost flat masses. *Calices* slightly prominent and placed at unequal distances (in general about $1\frac{1}{2}$ their diameter). *Costæ* irregularly confluent, large, rather thin, equally developed, flexuous or geniculated, delicately crenulated, and closely set (about a quarter of a line apart); 15 or 16 principal ones slightly exsert, terminated by an arched edge, extending almost to the centre of the visceral chamber, where they become very slender, bearing a small paliform lobe and alternating with an equal number of small septa; *wall* well developed, rather thick. *Columella* appearing to be slightly compressed. Diameter of the calices $1\frac{1}{2}$ line; depth almost half a line.

Found at Torquay; and at Valcos in the province of Leon in Spain.

In the Collection of the Geological Society of London, &c.

This species differs from *S. organum*[1] and *S. Torreanum*[2] by the costal radii being more numerous and more confluent.

Family Cystiphyllidæ, (p. lxxii.)

Genus Cystiphyllum, (p. lxxii.)

Cystiphyllum vesiculosum. Tab. LVI, figs. 1, 1*a*, 1*b*.

Cyathophyllum vesiculosum, *Goldfuss*, Petref. Germ., p. 58, pl. xvii, fig. 5, and pl. xviii, fig. 1, 1826.
— secundum, *Ibid.*, p. 58, pl. xviii, fig. 2.
— ceratites (pars), *Ibid.*, pl. xvii, fig. 2*k*.
— — *Milne Edwards*, 2d edit. of Lamarck, vol. ii, p. 430, 1836.
Cystiphyllum vesiculosum, *Phillips*, Palæoz. Foss., p. 10, pl. iv, fig. 12, 1841.
— — *De Verneuil* and *Jules Haime*, Bull. Soc. Géol. de France, 2d ser., vol. vii, p. 162, 1850.
— secundum and vesiculosum, *D'Orbigny*, Prod. de Pal., vol. i, p. 106, 1850.
— vesiculosum, *Milne Edwards* and *Jules Haime*, Pol. Foss. des Terr. Palæoz., p. 462, 1851.
— — *M'Coy*, Brit. Palæoz. Foss., p. 71, 1851.

Corallum simple, very long, slightly bent, subcylindrical, provided with a very strong epitheca, and presenting rather strong subhorizontal circular wrinkles. *Calicular* cavity rather deep; the septal striæ, when visible, more distinct towards the outer part of the calice. Vesicules unequal in size; the largest occupying the centre of the visceral cavity and about 1 line in length. Height of the coral in general about 3 or 4 inches. We have seen in the collection of Mr. Pengelly a specimen that measured above 1 foot in length, and $1\frac{1}{2}$ inch in diameter.

The British specimens submitted to our examination were found at Torquay, Plymouth,

[1] *Sarcinula organum*, Hisinger, Leth. Succ., p. 97, tab. xxviii, fig. 8, 1837.
[2] Milne Edwards and Jules Haime, Pol. Foss. des Terr. Palæoz., p. 452, 1851.

and Mudstone Bay; Prof. Phillips has met with the same species at Babbacombe, and Prof. M'Coy at Newton Bushel. It exists also in Spain at Millar, in the province of Leon; in Germany in the Eifel Mountains; and in North America at Corn Island, Falls of the Ohio.

This species differs from *C. lamellosum*[1] by its cylindroid form and its large transverse wrinkles. *C. cylindricum*[2] and *C. Siluriense*[3] are both easily distinguished from it by the existence of radiciform processes; and in *C. Grayi*[4] the vesicles are much more oblique towards the surface of the coral, and very irregular towards its centre.

[1] *Cyathophyllum lamellosum* and *placentiforme*, Goldfuss, Petref., tab. xviii, figs. 3, 4.

[2] Lonsdale, Silur. Syst., p. 691, pl. xvi bis, fig. 3, 1839.

[3] (Pars), Lonsdale, Ibid., pl. xvi bis, fig. 1.

[4] Milne Edwards and Jules Haime, Pol. Foss. des Terr. Palæoz., p. 465, 1851.

TAB. XLVII.

CORALS FROM THE DEVONIAN FORMATION.

HELIOLITES POROSA (p. 212).

Fig. 1. A vertical section made through a globular specimen found at Torquay, and belonging to the collection of Mr. Bowerbank; natural size.

1*a*, 1*b*, 1*c*. Portions of different transverse sections, showing the variations in the size of the calices. Figs. 1*a* and 1*c* are from different parts of the same specimen; natural size.

1*d*. A magnified view of part of the specimen figured in 1*a*, showing the structure of the cænenchyma and the septa.

1*e*. A magnified view of a portion of the vertical section, fig. 1, showing the tabulæ of the corallites and the dissepiments of the columnal cænenchyma.

1*f*. A specimen of the same species, in which the substance of the coral has been destroyed and the visceral chambers of the corallites filled up with extraneous matter, constituting small prominent cylinders. Found at Torquay by Mr. Pengelly.

BATTERSBYIA INÆQUALIS (p. 213).

Fig. 2. A transverse section polished; natural size. Specimen found at Teignmouth, and belonging to the collection of Dr. Battersby.

2*a*. A specimen showing the septa; natural size.

2*b*. The same, magnified.

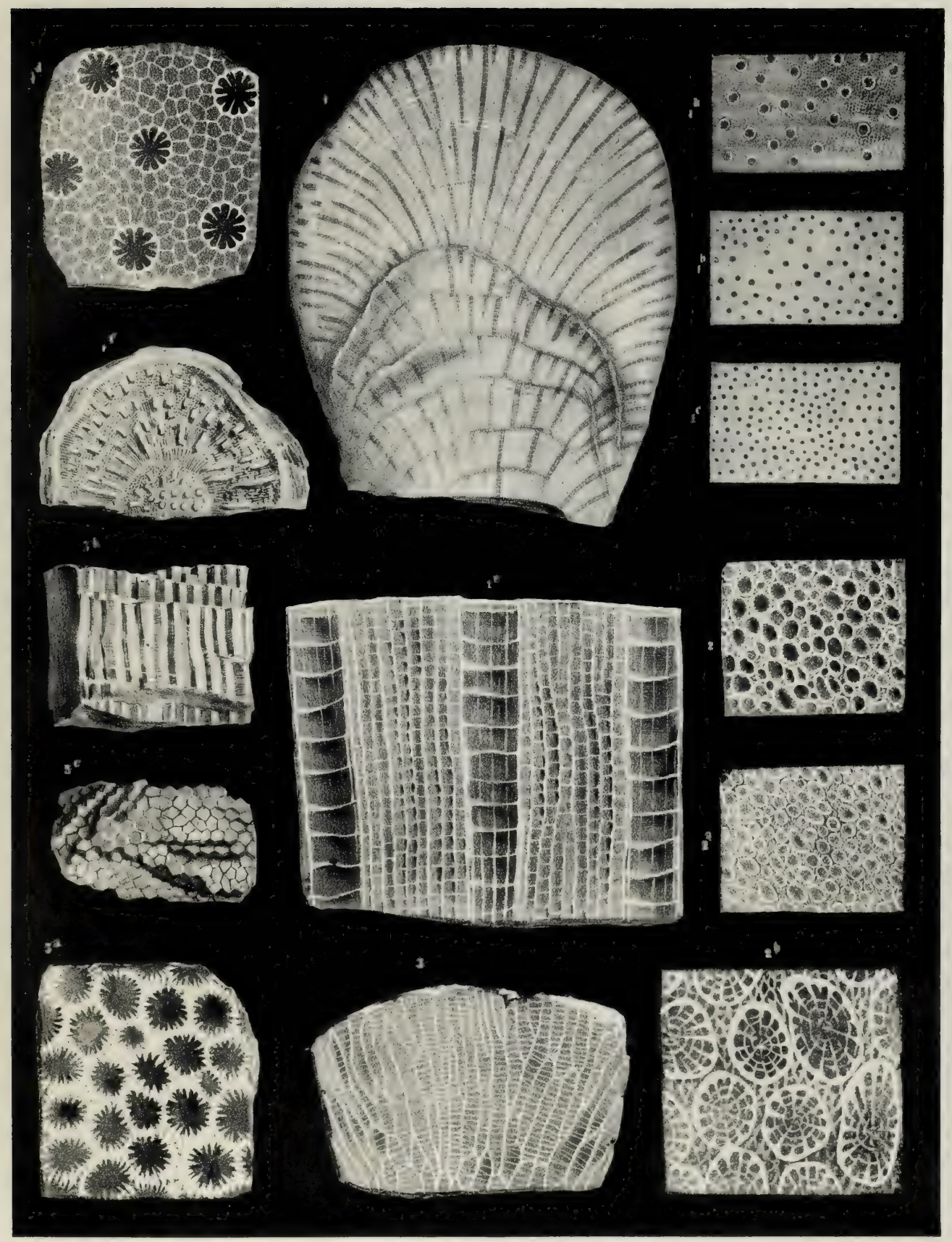
FAVOSITES GOLDFUSSI (p. 214).

Fig. 3. Vertical section polished; natural size. Specimen from Torquay, belonging to the collection of Mr. Bowerbank.

3*a*. Transverse section magnified, and showing some well-preserved calices with their septa.

3*b*. A fractured specimen, showing the prismatic form of the corallites; natural size. (Bowerbank collection.)

3*c*. The upper surface of the same specimen; natural size.



TAB. XLVIII.

CORALS FROM THE DEVONIAN FORMATION.

FAVOSITES RETICULATA (p. 215).

Fig. 1. A specimen found at Torquay, and belonging to the collection of Dr. Battersby; natural size.

1*a*. A few calices of the same fossil, magnified.

1*b*. A vertical section of a specimen from Torquay, given to the Parisian Museum by Professor Milne Edwards.

FAVOSITES CERVICORNIS (p. 216).

Fig. 2. A vertical section of a specimen from Torquay, belonging to the collection of the Geological Society; natural size.

FAVOSITES FIBROSA (p. 217).

Fig. 3. Vertical section of a specimen from Torquay belonging to Dr. Battersby; natural size.

3*a*. A portion of the same, magnified, to show the septa and the visceral chambers of the corallites.

3*b*. A portion of the same, showing some calices that have been modified in their structure by the process of fossilization; magnified.

EMMONSIA HEMISPHERICA (p. 218).

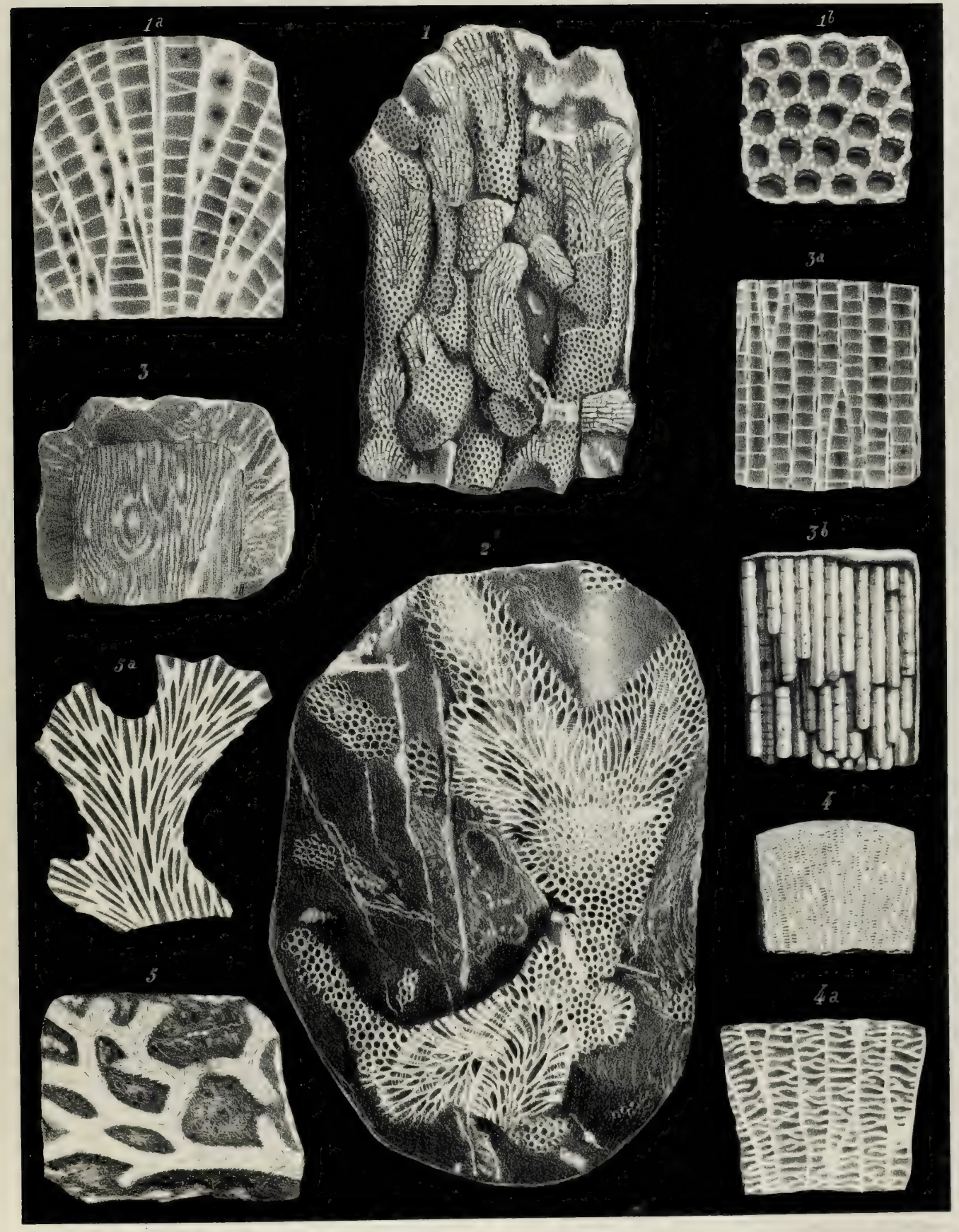
Fig. 4. Part of a vertical section of a specimen from Torquay, belonging to Dr. Battersby; natural size.

4*a*. Part of the same, magnified.

ALVEOLITES VERMICULARIS (p. 220).

Fig. 5. Vertical section of a specimen from Torquay, belonging to the authors; natural size.

5*a*. Part of the same, magnified.


1a
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1b
3a
3
3b
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5a
4
5
4a

TAB. XLIX.

CORALS FROM THE DEVONIAN FORMATION.

ALVEOLITES SUBORBICULARIS (p. 219).

Fig. 1. A polished vertical section of a specimen from Torquay belonging to Mr. Pengelly.

1*a*. An oblique section, magnified.

ALVEOLITES BATTERSBYI (p. 220).

Fig. 2. A vertical section of a specimen from Torquay, belonging to Dr. Battersby; natural size.

2*a*. A part of the same, magnified, and showing the trabecular septa.

ALVEOLITES COMPRESSA (p. 221).

Fig. 3. Part of a transverse section of a specimen from Torquay, belonging to Mr. Pengelly.

METRIOPHYLLUM BATTERSBYI (p. 222).

Fig. 4. Transverse section of a specimen from Torquay, belonging to Dr. Battersby; double the natural size.

AMPLEXUS TORTUOSUS (p. 222).

Fig. 5*a*. Vertical section of a specimen from Plymouth, belonging to Mr. Pengelly.

HALLIA PENGELLYI (p. 223).

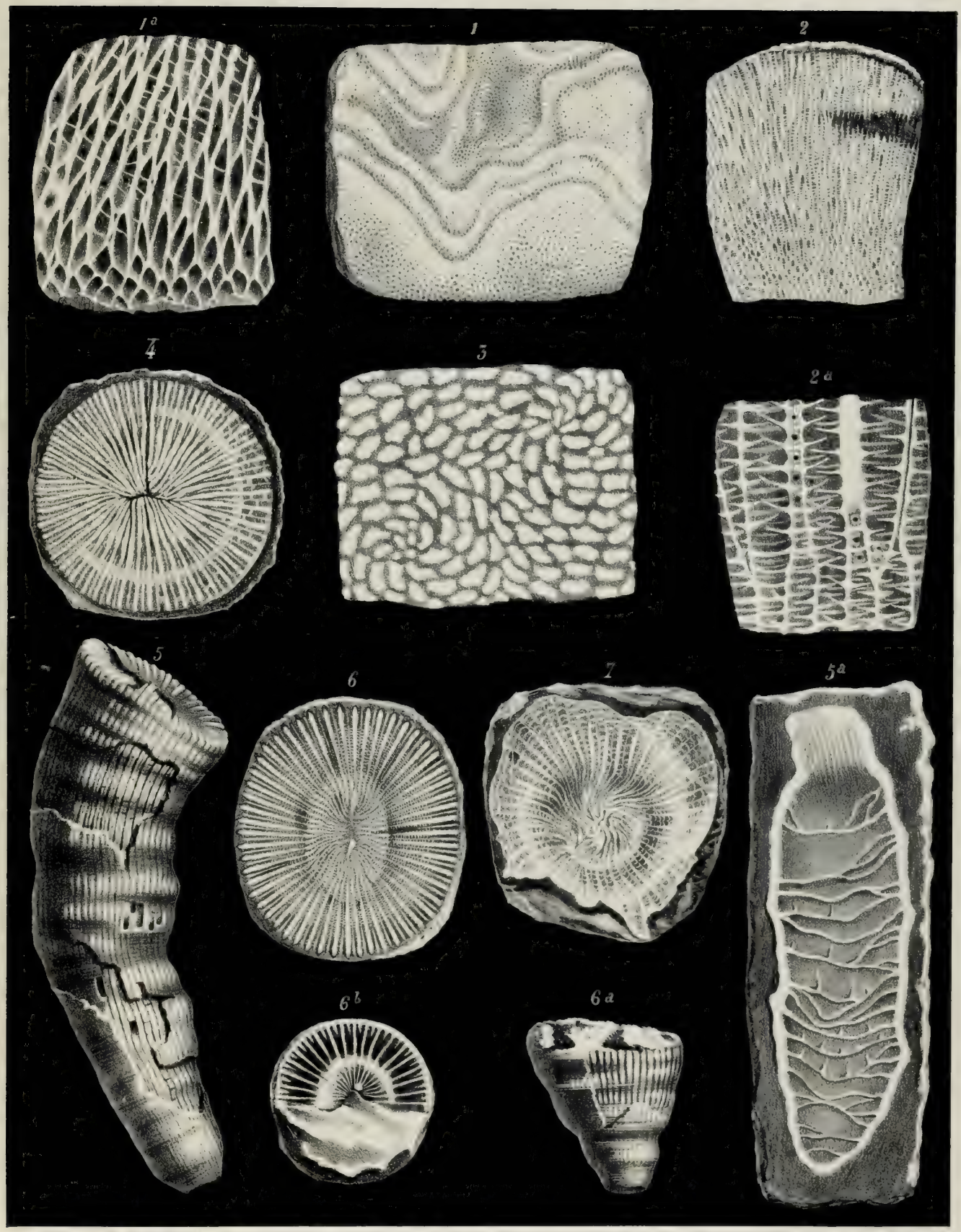
Fig. 6. Transverse section of a specimen from Torquay, belonging to Mr. Pengelly.

6*a*. A specimen from Petherwin, belonging to the collection of the Geological Society of London; natural size.

6*b*. A side view of the same.

CYATHOPHYLLUM OBTORTUM (p. 225).

Fig. 7. Transverse section of a specimen from Torquay, belonging to Professor Phillips; double the natural size.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2a
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5a
6b
6a

TAB. L.

CORALS FROM THE DEVONIAN FORMATION.

CYATHOPHYLLUM DAMNONIENSE (p. 225).

Fig. 1. An oblique section of a specimen from Torquay, belonging to Dr. Battersby; natural size.

CYATHOPHYLLUM CERATITES (p. 224).

Fig. 2. A young individual from Barton quarry, near Newton, belonging to Dr. Battersby; natural size.

CYATHOPHYLLUM ROEMERI (p. 224).

Fig. 3. Transverse section of a specimen from Torquay, belonging to Dr. Battersby; double the natural size.

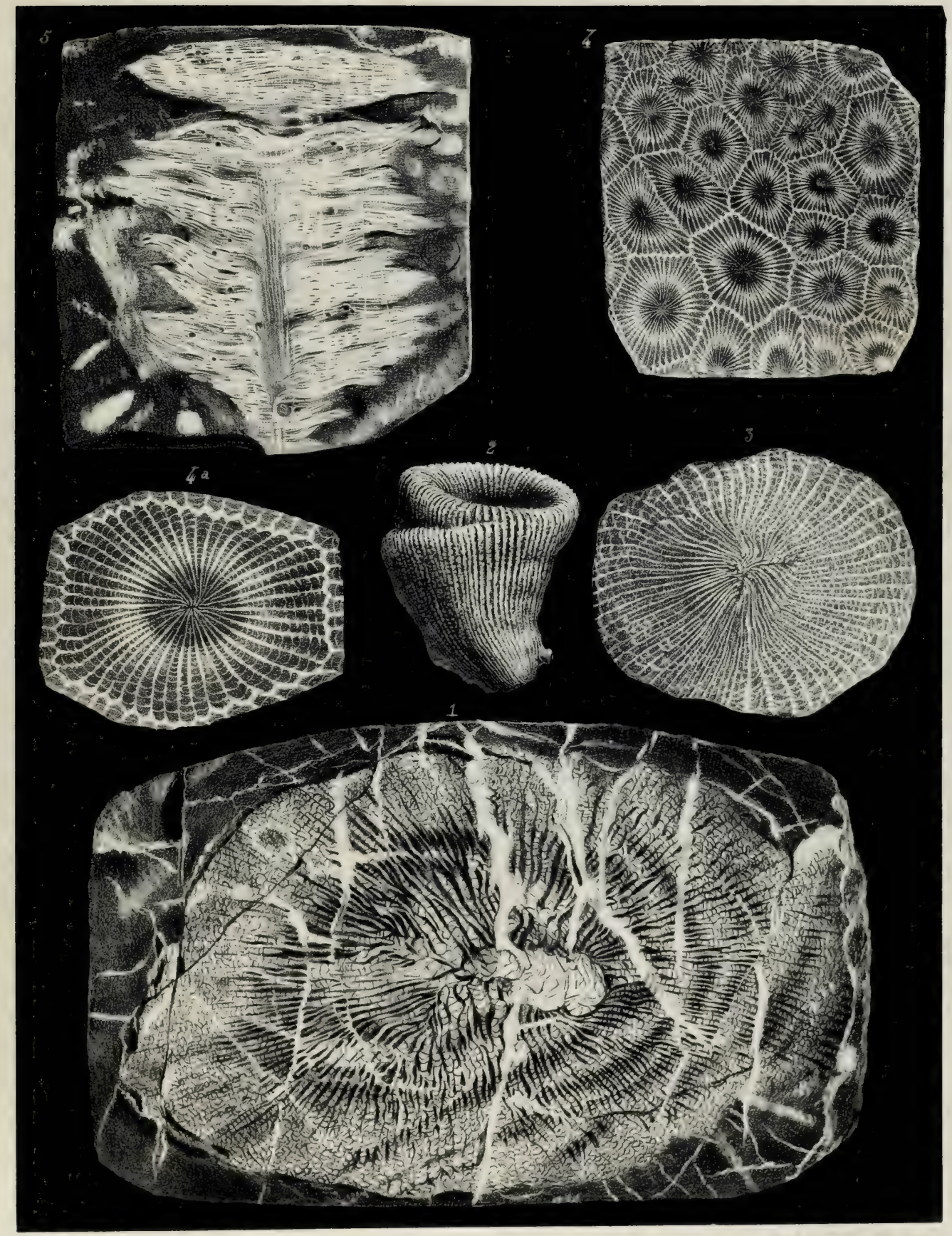
CYATHOPHYLLUM HEXAGONUM (p. 228).

Fig. 4. Transverse section of a specimen from Torquay, belonging to Dr. Battersby; natural size.

4*a*. One of the above calices magnified.

CHONOPHYLLUM PERFOLIATUM (p. 235).

Fig. 5. Vertical section of an individual imbedded in extraneous matter, from Torquay; natural size. (Collection of Dr. Battersby.)


5
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4 a
2
3
1

TAB. LI.

CORALS FROM THE DEVONIAN FORMATION.

CYATHOPHYLLUM HELIANTHOIDES (p. 227).

Fig. 1. Transverse section of a simple corallum, from Torquay, belonging to Dr. Battersby; natural size.

1*a*. Transverse section of a compound corallum, found at Plymouth by Mr. Pengelly; natural size.

CYATHOPHYLLUM CÆSPITOSUM (p. 229.)

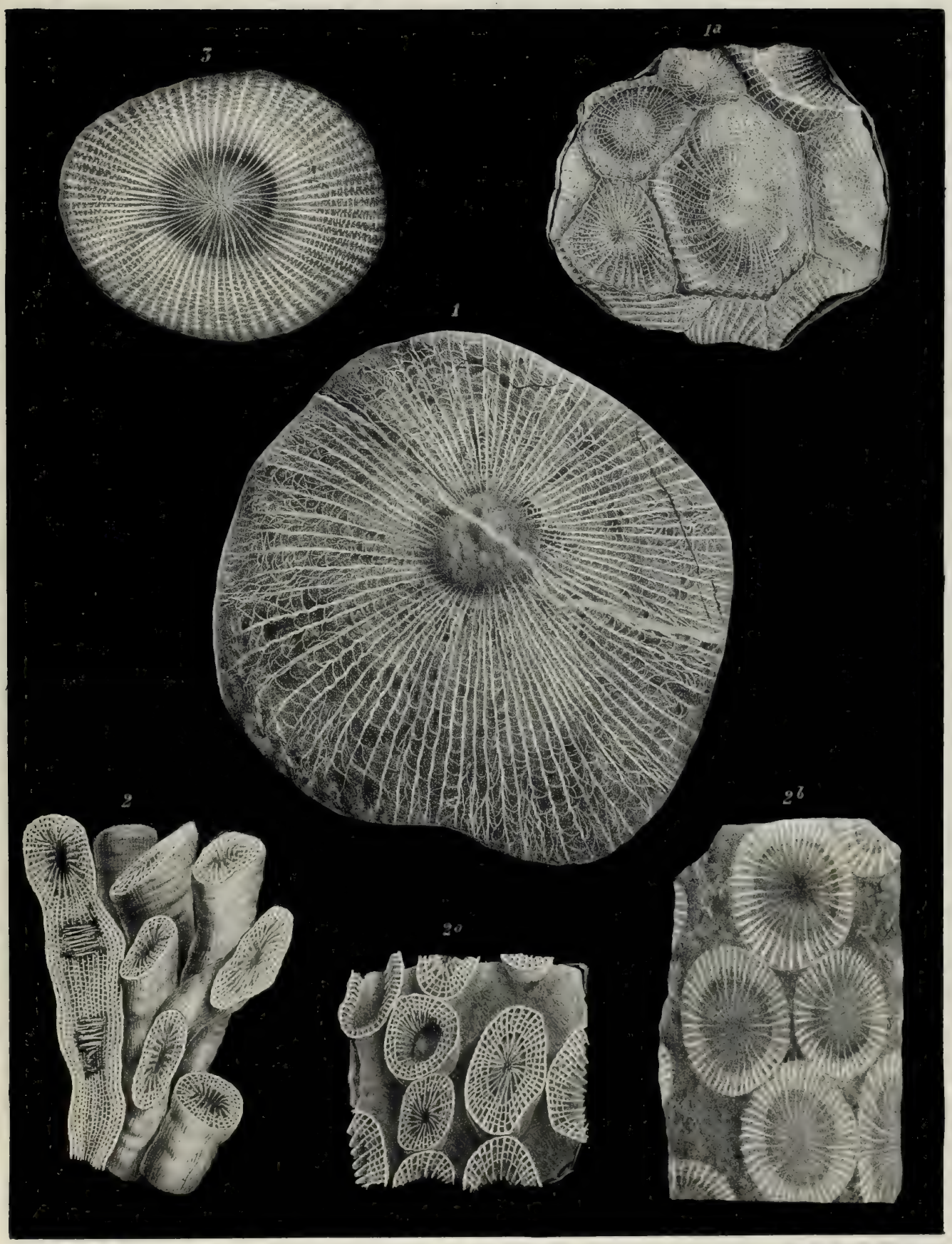
Fig. 2. A fractured specimen, showing the structural characters; natural size. From Torquay, Dr. Battersby's collection.

2*a*. A transverse section of some of the same corallites, somewhat magnified.

2*b*. A polished slab, showing a transverse section of a specimen from Teignmouth beach, belonging to the collection of Mr. Bowerbank.

HELIOPHYLLUM HALLI (p. 235).

Fig. 3. Transverse section of a specimen from Torquay, belonging to Dr. Battersby; double the natural size.



Pl. ackerbauer ad nat. in lap. del.

TAB. LII.

CORALS FROM THE DEVONIAN FORMATION.

CYATHOPHYLLUM BOLONIENSE (p. 230).

Fig. 1. Upper surface of a specimen modified by fossilization; found at Ogwell by Dr. Battersby.

1*a*. Part of a transverse section of a specimen from Torquay, magnified. (Collection of Dr. Battersby.)

CYATHOPHYLLUM ÆQUISEPTATUM (p. 232).

Fig. 2. A specimen showing the calices of a few corallites imbedded in extraneous matter; found at Ilfracombe, and belonging to the collection of the Geological Society of London; natural size.

CYATHOPHYLLUM SEDGWICKI (p. 231).

Fig. 3. A polished slab, showing a transverse section of a specimen found at Torquay, and belonging to Mr. Bowerbank's collection; natural size.

3*a*. A part of the same, magnified.

CYATHOPHYLLUM MARMINI (p. 231).

Fig. 4. A polished transverse section of a specimen from Torquay, belonging to Dr. Battersby; natural size.

4*a*. Part of the same, magnified.

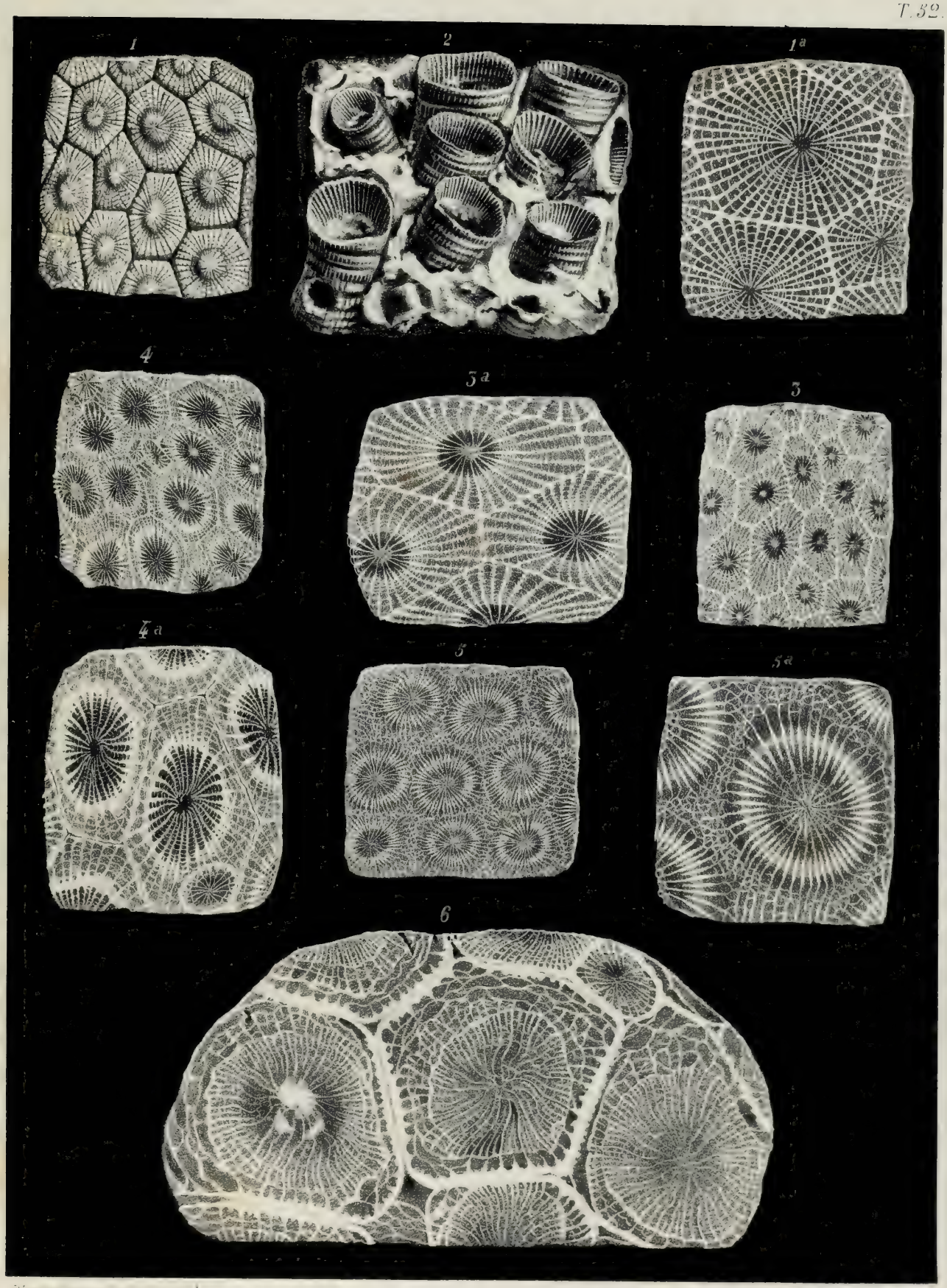
PACHYPHYLLUM DEVONIENSE (p. 234).

Fig. 5. A polished transverse section of a specimen from Torquay, belonging to Dr. Battersby; natural size.

5*a*. Part of the same, magnified.

ENDOPHYLLUM ABDITUM (p. 233).

Fig. 6. Transverse section of a specimen from Teignmouth beach, belonging to Dr. Battersby; natural size.


1
2
1a
4
3a
3
4a
5
5a
6

TAB. LIII.

CORALS FROM THE DEVONIAN FORMATION.

ENDOPHYLLUM BOWERBANKI (p. 233).

Fig. 1. A transverse section of a specimen found at Barton, and belonging to Mr. Bowerbank; natural size.

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2*a*. Transverse section of another specimen from the same locality belonging to Dr. Battersby; magnified.

ACERVULARIA GOLDFUSSI (p. 236).

Fig. 3. Transverse section of a specimen from Torquay, belonging to Dr. Battersby; natural size.

3*a*. Part of the same slab, magnified.

ACERVULARIA CORONATA (p. 237).

Fig. 4. A specimen modified in its structure by the process of fossilization; from Torquay, and belonging to Mr. Pengelly; natural size.

4*a*. Transverse section of a specimen from Barton, belonging to Dr. Battersby; natural size.

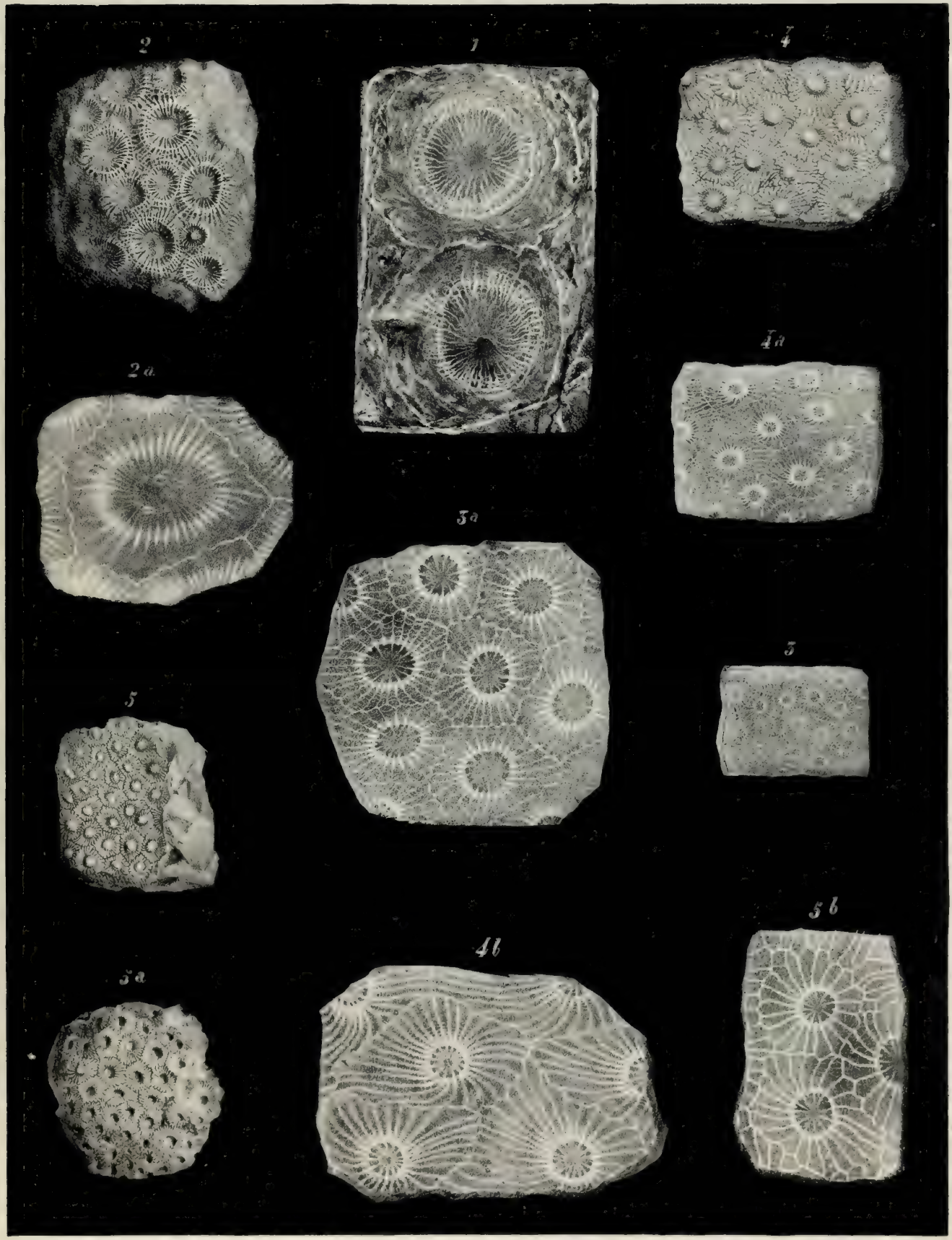
4*b*. A portion of the same section, magnified.

ACERVULARIA PENTAGONA (p. 238).

Fig. 5. A specimen modified by the process of fossilization; from Torquay, and belonging to Mr. Pengelly; natural size.

5*a*. A specimen from Ogwell, belonging to Mr. Bowerbank's collection; natural size.

5*b*. A portion of a transverse section of another specimen from the same locality; (Mr. Bowerbank's collection); natural size.


2
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3
5
5b
4b
5a

TAB. LIV.

CORALS FROM THE DEVONIAN FORMATION.

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1*a*. A part of the same, magnified.

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Fig. 2. Transverse section of a polished specimen from Torquay, belonging to Dr. Battersby; natural size.

2*a*. A part of the same slab, magnified.

ACERVULARIA RŒMERI (p. 239).

Fig. 3. Transverse section of a specimen from Torquay; natural size; Dr. Battersby's collection.

3*a*. Part of the same slab, magnified.

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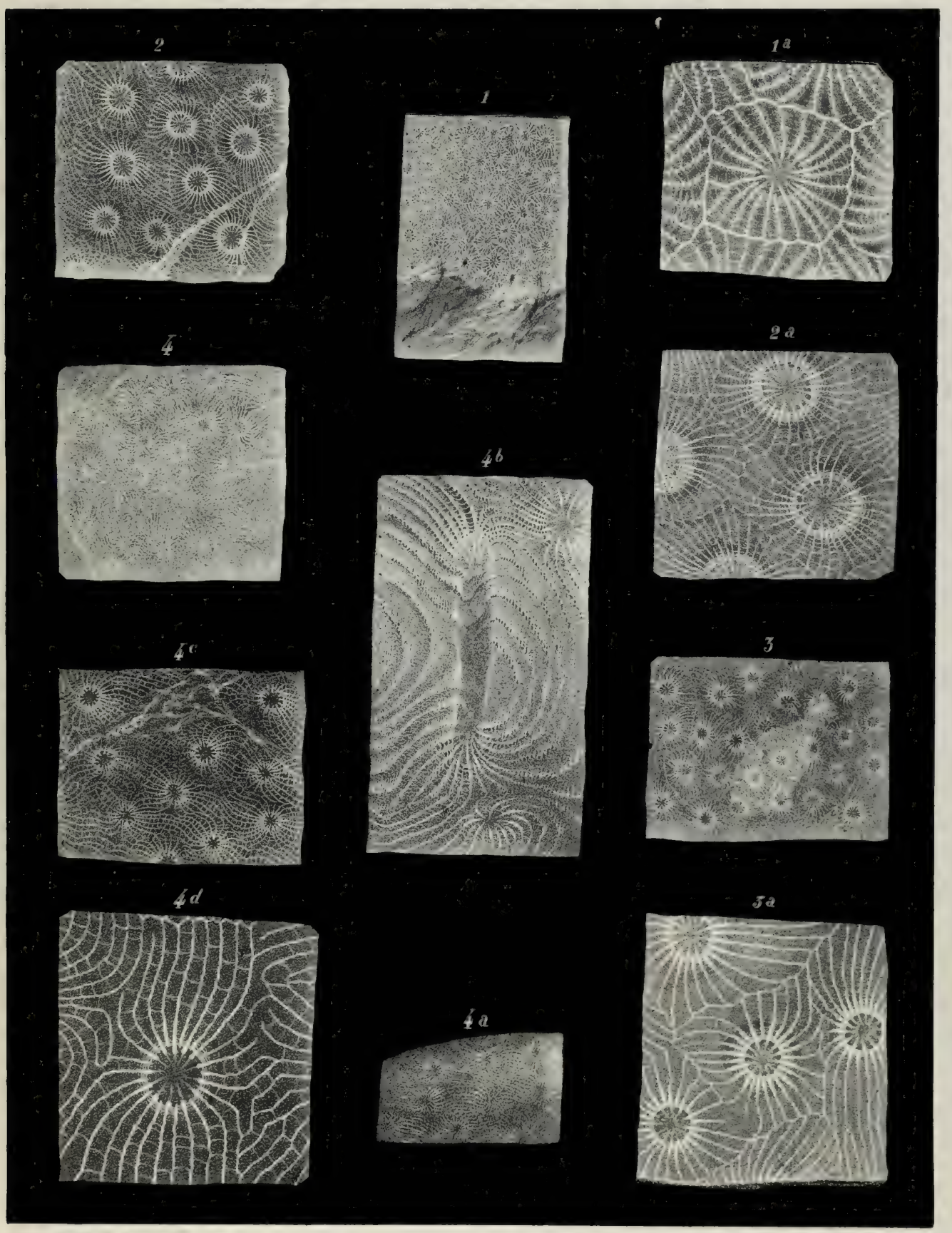
Fig. 4. Transverse section of a specimen from Teignmouth beach; natural size; (Dr. Battersby's collection).

4*a*. Another specimen from Torquay.

4*b*. An oblique section of a specimen from Torquay; somewhat magnified.

4*c*. Transverse section of another specimen from Torquay; natural size; (Dr. Battersby's collection).

4*d*. Part of the same slab, magnified.


2
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1a
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TAB. LV.

CORALS FROM THE DEVONIAN FORMATION.

SMITHIA PENGELLYI (p. 241).

Fig. 1. Transverse section of a specimen from Torquay, belonging to Mr. Bowerbank; natural size.

1*a*. A part of the same, magnified.

1*b*. Another specimen, from the same locality.

SMITHIA BOWERBANKI (p. 241).

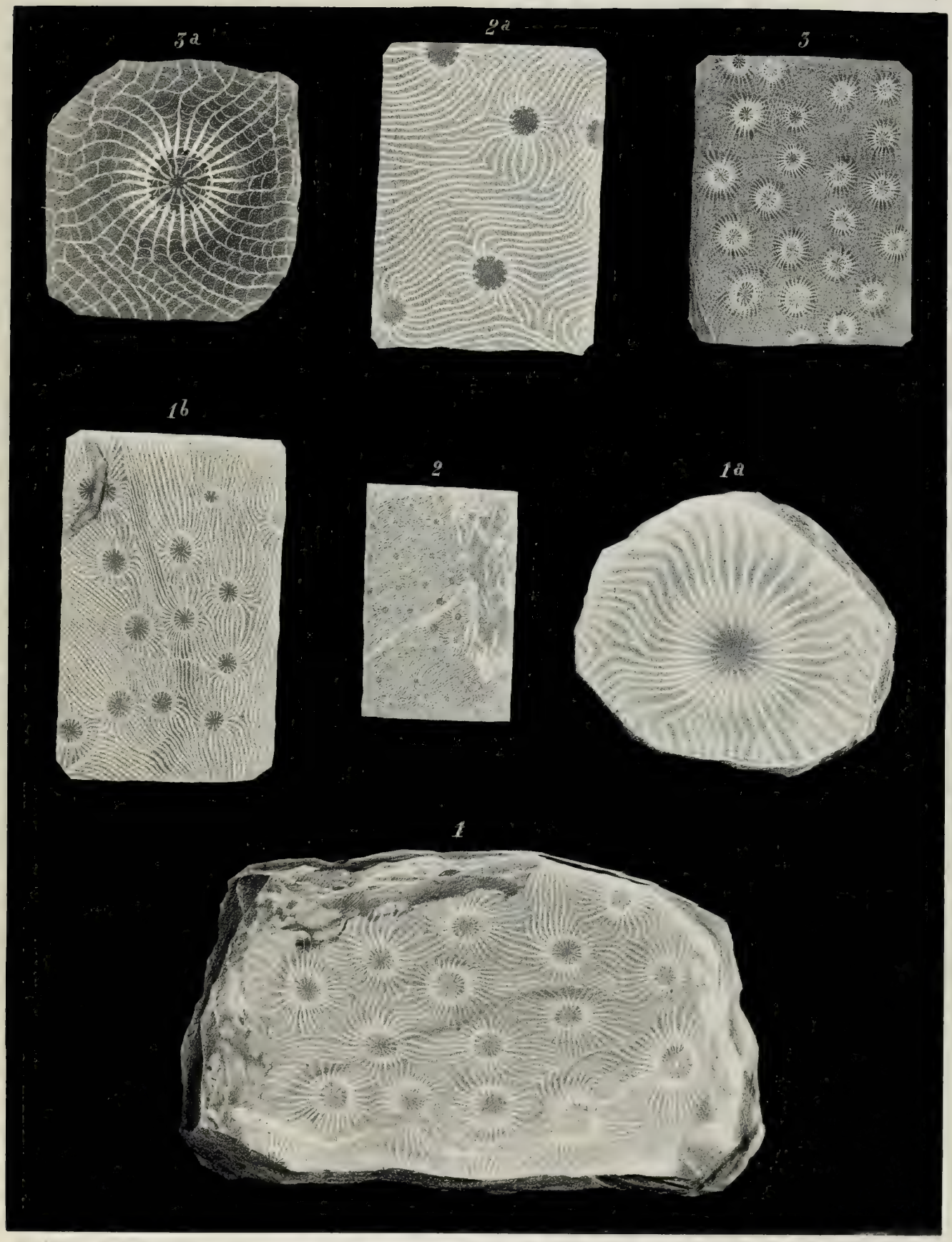
Fig. 2. A polished specimen from Torquay, belonging to Dr. Battersby; natural size.

2*a*. Part of the same, magnified.

SYRINGOPHYLLUM CANTABRICUM (p. 242).

Fig. 3. Transverse section of a specimen from Teignmouth, belonging to the collection of the Geological Society of London; natural size.

3*a*. Part of the same, magnified.


3a
2a
3
1b
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1a
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TAB. LVI.

CORALS FROM THE DEVONIAN FORMATION.

CYSTOPHYLLUM VESICULOSUM (p. 243).

Fig. 1. Side view of a coral from Torquay, belonging to Mr. Pengelly; natural size.

1*a*. A transverse section of another specimen from the same locality; natural size.

1*b*. Part of a vertical section of a specimen from Mudstone Bay, belonging to Dr. Battersby; natural size.

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Fig. 2. Transverse section of a specimen with thick walls, from Torquay; natural size.

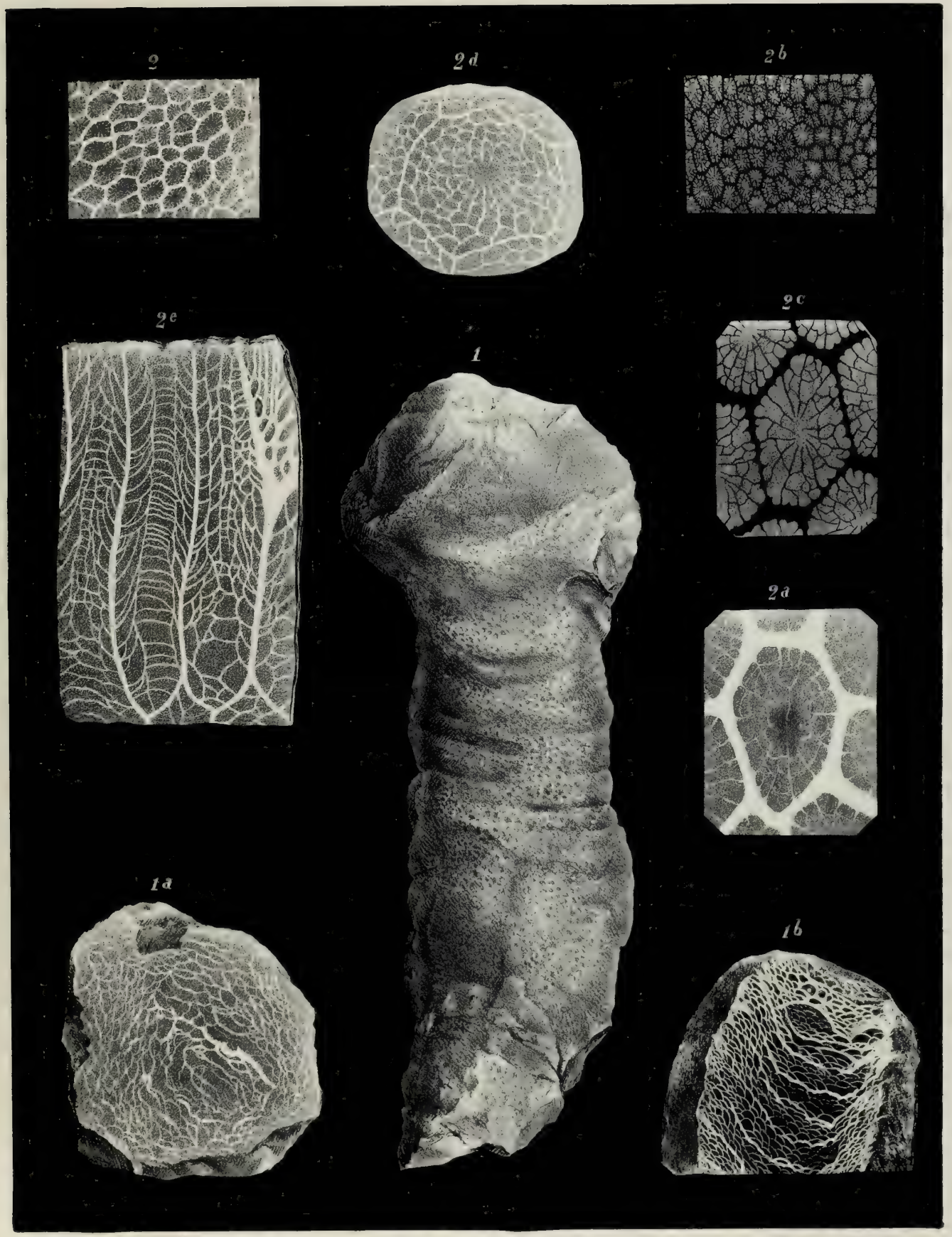
2*a*. Part of the same, magnified.

2*b*. Specimen with thin walls; natural size.

2*c*. Part of the same, magnified.

2*d*. Another specimen from Torquay, with walls still thinner, and the vertical dissepiments stronger than in the preceding ones, magnified.

2*e*. A vertical section magnified.


2
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BRITISH

FOSSIL BRACHIOPODA.

BY

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ROYAL SOCIETY OF SCIENCES OF LIEGE; ZOOLOGICAL SOCIETY OF VIENNA. &c

VOL. I.

WITH

A GENERAL INTRODUCTION:

I. ON THE ANATOMY OF TEREBRATULA.

BY PROFESSOR OWEN, M.D., LL.D., F.R.S., L.S., G.S., ETC.

II. ON THE INTIMATE STRUCTURE OF THE SHELLS OF THE BRACHIOPODA.

BY PROFESSOR CARPENTER, M.D., F.R.S., G.S., ETC

III. ON THE CLASSIFICATION OF THE BRACHIOPODA.

BY THOMAS DAVIDSON, F.G.S., ETC.

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PREFACE.

Of all the species composing the SUB-KINGDOM MOLLUSCA, none are, perhaps, more varied, more elegant in their shapes, or more abundantly distributed, than those to which the term BRACHIOPODA or PALLIOBRANCHIATA has been applied: they are found in the oldest deposits at present known to contain vestiges of animal life, and have continued to exist, some in similar, but many under different shapes to the existing forms, through the long successive periods which lead us to the present time. Their value to the geologist is consequently very great; and, as they so commonly fall under his hammer, where other classes are often but sparingly represented, they must, therefore, be looked upon as excellent data for the age of the deposit; for, although some few individual forms pass from one stage to the other, the generality are limited to defined horizons. The study of so important an ORDER has, within the last fifteen or twenty years, particularly interested the Palæontologist who regarded something more than *external shape*. His efforts, in this direction, have tended to acquire an intimate acquaintance with the inhabitants of so remarkable a shell; and we have become more and more convinced that to arrive at so desirable a knowledge, it was absolutely necessary to call upon ZOOLOGY to point out, from a minute study of the animal, of the few species and genera still existent, the use and origin of those remarkable calcified processes and varied impressions visible in the numerous forms now extinct.

Having devoted many years to the careful investigation of the subject under consideration, and feeling desirous to contribute the little in my power to the advancement of the views so laudably put forth by the Palæontographical Society, in 1849 I proposed to the Council to do my best to prepare for them a general work on all the British species of Brachiopoda hitherto discovered,[1] arranged in seven distinct parts, which

[1] From being almost a stranger in the country at the period above mentioned, on account of a residence of many years in different parts of the continent, I did not sufficiently estimate all the difficulties I should have had to contend with in preparing so extensive and difficult a work *entirely on British species*. I had not only to become acquainted with the local geologists and their collections, but also with a

would correspond to the great geological divisions or systems now in general use, viz. :—

1. Tertiary.
2. Cretaceous.
3. Oolitic.
4. Permian.
5. Carboniferous.
6. Devonian.
7. Silurian.

So that each Part would form a complete Monograph zoologically arranged as far as the state of our present knowledge will admit.[1]

It has also been considered desirable to preface the main subject of this work by some preliminary observations on the class in general; in order to enable the reader better to understand why certain sections and names have been rejected, or admitted in preference to others; and it has afforded me no small pleasure to find that Professor Owen and Dr. Carpenter were likewise disposed to annex their recent and most important anatomical and structural investigations to the general Introduction I was then preparing. And, in accepting so liberal an offer from those eminent and justly celebrated zoologists, I felt convinced that I was attending not only to the best interests of Science, but also to those of the Society,—interests which it is the main object and desire of all the members to advance.

THOS. DAVIDSON.

London; *January* 4, 1853.

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great number of the localities themselves: and, from having been at the commencement more prepared with the Oolitic species, I deemed it advisable to begin with them, especially, as by so doing, no subsequent inconvenience would be incurred by the members of the Society. I must also avail myself of this opportunity to express my warmest thanks to all those local geologists who have so kindly and liberally assisted in the prosecution of my investigations; many of these gentlemen I have already had the pleasure of naming in portions of the work already published, and, in addition, I have now the satisfaction of mentioning Professor Owen, Dr. Carpenter, Drs. Gray, Volborth, and Perier; Professors Beyrich and Kutorga; Col. Helmersen; Messrs. Salter, Cuming, Hanley, de Lorière, de Hagenow, and Michelotti; and I am most particularly indebted to Professor King, Mr. Woodward, and M. Suess, of Vienna, for much valuable information, and for the kind interest they have shown in the progress of the work.

[1] It has been estimated that the work now in progress will require from eighty to one hundred plates, and it was found desirable to divide the subject into two volumes, the first will be devoted to the *Tertiary*, *Cretaceous*, and *Oolitic* species; the second, to the *Palæozoic* forms.

INTRODUCTION.

CHAPTER I.

ON THE ANATOMY OF THE TEREBRATULA.

By PROFESSOR OWEN, F.R.S., F.G.S., &c.

With the view of extending the knowledge of the organisation of the Brachiopoda, the unfolding of which Pallas and Cuvier had so well begun—the one in the description of his so-called *Anomia*,[1] the other by his admirable anatomy of the *Lingula anatina*,[2]—I communicated, in 1833, an account of my dissections of some species of *Terebratula* and *Orbicula* to the Zoological Society of London,[3] and have since availed myself of every opportunity of completing the anatomy of this very beautiful and singular class of Mollusks.

Cuvier had shown, in *Lingula*, a condition of the respiratory organ, which might be paralleled with one of the transitory states of that organ in the Lamellibranchs, that, viz. in which the rudimental gills appear as processes from the inner surface of the pallial lobes, and in which the distinction, whether morphological or physiological, of the gills and mantle is not fully established: the modifications of the breathing organ in both *Terebratula* and *Orbicula* exhibited a more interesting condition, comparable to a still earlier stage of the respiratory system in the embryo Lamellibranch, that, viz. in which the vessels of the pallial lobes have not begun to bud out in parallel rows of vascular loops,—the first stage in the formation of gills, and the one at which it is arrested in the *Lingula*. Notwithstanding, therefore, the manifestation of many beautiful modifications of structure, which seemed to render the organisation of the Brachiopod more complex than that of the ordinary Bivalve, I was led, in 1833, to regard the latter as standing higher in the Acephalous series, and to place the *Brachiopoda* between the *Lamellibranchiata* and the *Tunicata*: subsequent investigations, especially those recorded in the present Memoir, have confirmed me in that view. I am the more desirous to repeat these convictions in reference to the

[1] Miscellanea Zoologica, 4to, 1775, p. 182, (*Anomiarum Biga.*)

[2] Annales du Muséum d'Hist. Nat., 4to, tom. i, p. 69 (1802). Mémoires pour servir à l'Histoire et l'Anatomie des Mollusques, 4to, 1817.

[3] Transactions of the Zoological Society of London, 4to, vol. i, p. 145 (1835).

position and affinities of the acephalous Mollusks, because my statement as to the value of the group *Brachiopoda*, in comparison with the group *Lamellibranchiata*,[1] has been misunderstood by some esteemed contemporaries on the continent. I believe the *Brachiopoda* and *Lamellibranchiata* to have equal claims to be considered as distinct groups, whether called classes, sub-classes, or orders of *Acephala;* but, I regard the group *Brachiopoda* as exemplifying a less advanced grade of organisation than the *Lamellibranchiata*, in which the lowest forms, as, *e. g. Anomia* and *Ostrea*, show the nearest affinities to the *Brachiopoda*. Those monomyary or unimuscular bivalves become fixed, like the *Orbiculæ* and *Terebratulæ*, whilst the higher Lamellibranchs exhibit, with a progressive development and increased complexity of the muscular system, powers of locomotion more or less active and varied; some, *e. g.* the Solens, burrowing; others, *e. g.* the Cardiums, progressing by short leaps, whence the name *subsilentia*, given to the group by Poli; others, again, *e. g.* the Pectens, are said to swim by violent flapping movements of their valves, whence these light and richly-painted bivalves have been called "Sea-butterflies."

The Brachiopoda, being deprived of the power of locomotion, have the development of their respiratory system arrested at a corresponding low grade; the *Lingulæ*, which have the largest and most flexible peduncle, being the only forms that show distinct rudiments of gills. In the *Terebratulæ*, the mantle-lobes, besides their ordinary office, perform by their rich vascularity the breathing function. The admirable microscopical researches of Dr. Carpenter and Prof. Quekett have demonstrated that close and intimate adhesion of the mantle to the shell, which was noticed in my earlier dissections of the *Terebratula*,[2] to be due to the penetration of the pores of the shell by minute tubular membranous processes, which they believe to be glandular cæca.[3] These processes may perform an excretory function, and be associated in that action with the depurative respiratory office of the mantle, the probable condition of their development being the low grade of the proper branchial organisation, or they may take some share in the formation of the shell itself, necessitated by the modification of the mantle to subserve respiration.

[1] "M. Owen a été le premier à faire remarquer que les Brachiopodes ne doivent pas être envisages comme une classe à part, mais qu'ils peuvent être convenablement rangés sur la même ligne que les Monomyaires et les Dimyaires." (Agassiz, in 'Poissons Fossiles' of the "Old Red," 4to, 1845, p. 15.) Compare, however, 'Zool. Trans.,' vol. i, 1835, p. 159:—

"In all the essential points, the *Brachiopoda* closely correspond with the *Acephalous Mollusca*, and I consider them as being intermediate to the *Lamellibranchiate* and *Tunicate* orders; not, however, possessing, so far as they are at present known, distinctive characters of sufficient importance to justify their being regarded as a distinct class of Mollusks, but forming a separate group of equal value with the *Lamellibranchiata*."

[2] Trans. Zool. Soc., vol. i, p. 147.

[3] Carpenter, Report on the Microscopic Structure of Shells, Part II, Trans. Brit. Association, 1847, p. 93. "In these tubes, as will hereafter be shown, certain cæcal appendages of animal membrane are situated."—Quekett, 'Histological Catalogue,' vol. i, 1850, p. 270. In the same work it is shown that "each perforation has a series of radiating lines or tubes on its outer margin," (p. 270). The corresponding parts of the membranous tubes would resemble a terminal brush of vibratile cilia.

To the question proposed to me by their discoverer, "Can they have any analogy to the hepatic papillæ of the Nudibranchiates?" I could only reply that, the pallial lobes are so distinct from the visceral mass, as compared with the skin of the Nudibranchiates, that they cannot have any special functional relation to the liver. And, in regard to the generative system, the membranous tubes penetrating the shell-pores in the *Terebratula flavescens* are so much more minute than the ova discernible in the ramified ovaria, and their presence is so equally manifested over the non-ovarian and ovarian parts of the mantle—the same remark being equally applicable to the pallial lobes and ramified testes in the male—that one cannot connect them, as subordinately related in function, with the generative organs.

The difficulty of satisfactorily assigning the final cause or purpose of the microscopic pallial processes is increased, as in many analogous cases, by the non-development of the organs in question in certain *Brachiopoda*, *e. g.*, the recent *Atrypa* and the fossil *Rhynconellidæ*, which latter, from the general analogy of the structure of their shell, might be supposed to have the respiratory organs at the same low degree of development as the *Terebratulidæ*, and to have the same need for the minute calcifying or excretory ciliated shell-tubes.

Owing to this organic connection between the pallial lobes and the shell, which is particularly close towards the periphery of the lobes, I have been compelled, in some of my dissections, to sacrifice the shell, and remove it piecemeal, in order to preserve and show the characters of the external lobes of the mantle entire. The difficulty of removing the imperforate valve is increased by the median crest, *d*, fig. 1, p. 9, and the attachments of the loop, *ib.*, *e e*, both of which require to be broken close off from the imperforate valve, and left inclosed in the folds of the mantle that invest them, in order to obviate laceration of its outer surface.

The dorsal lobe, D *p*, of the mantle, thus exposed in the *Terebratula flavescens*, shows the single pair of wide pallial sinuses, 5, containing the correspondingly ramified testes or ovarium, according to the sex; the sinuses and their contents extending from the outer side of the hepatic portion of the visceral mass, forwards, along the outside of the great anterior muscular impressions, to near the anterior border of the mantle: the sinus is equidistant from the median line and the lateral border of the mantle, in each half of the lobe: the marginal ramifications of the sinus, the large sheathed cilia, and the smaller marginal cilia, correspond in structure with the same parts in *Ter. chilensis*.[1] Immediately behind a line equally bisecting transversely the mantle lobe in question, are the expanded extremities of attachment of the two divisions, *o' p'*, fig. 1, p. 9, of the *adductor longus* muscle, ("anterior pair of muscles arising from the imperforate valve," tom. cit., 1833, p. 161, pl. xxii, fig. 6, *Ter. chilensis*.)

In the space behind these muscles, and between them and the *retractores superiores*, the two lateral masses of hepatic cæca are clearly visible beneath the thin transparent pallial covering. Behind the *retractores superiores*, ("posterior pairs of muscles arising

[1] Trans. Zool. Soc., pp. 147, 148, pl. xxii, fig. 11.

from the imperforate valve," tom. cit., 1833, p. 161, pl. xxii, fig. 6, *Ter. chilensis*,) near the middle line, and close to the hinder margin of the dorso-pallial lobe, are the short, approximate tendinous insertions of the *adductor brevis*, q', and the line of attachment of the almost tendinous *cardinales* muscles, u'.

The exterior surface of the ventral lobe, when exposed with the same care, shows the two pairs of pallial sinuses and ramified generative lobes. The muscular extremities perforating this lobe are more aggregated than in the opposite lobe: the anterior, forming a pair, of a pyriform shape, with the great end forwards, belong to the *adductor brevis*, q', fig. 2, p. 9, ("anterior pair of muscles arising from the perforate valve," tom. cit., 1833, p. 161, pl. xxii, fig. 5, *Ter. chilensis*): external and posterior to these is a second pair of muscular attachments belonging to the '*retractor inferior*,' *ib.* s', ("posterior pair of muscles of the perforate valve," tom. cit., 1833, p. 162, pl. xxii, fig. 5;) in the median interspace of the foregoing muscles is the common attached extremity of the *adductores longi*, *ib.* o': of a pyriform figure, with the great end backwards, and emarginate or notched at the middle from the lodgment of the anal end of the intestine, *ib.* ψ. Immediately behind this part are the ends of the small pair of *cardinales* muscles, *ib.* u', and behind these the transversely extended glistening surface of attachment of the musculo-aponeurotic fibres of the sheath of the peduncle (*capsularis* r').

As in the *Terebratulæ* described in my former Memoir, the pallial lobes, with the exception of the small part at the hinge of the shell, are free in the rest of their circumference, and inclose a wide cavity to which the sea-water is admitted, and in which float freely the long filaments of the fringed arms. The long adductors and expanded origins of the short adductors appear also to cross the pallial cavity, but they are inclosed by a delicate transparent duplicature of the pallial membrane: a similar duplicature invests the beginning of the œsophagus, and is bent around the terminal part of the intestine, being reflected upwards a little above the vent, which opens, like the mouth, into the pallial interspace, immediately behind the ventral insertion of the long adductors. The visceral mass, consisting of the alimentary canal, pl. i, fig. 1, τ, ϕ, χ, liver, ω, hearts, 1, and looped origins of the ventral ovaria or testes, pl. iii, fig. 1, 12, occupies the small space between the long adductors, o, p, the hinge, and the peduncle.

MUSCULAR SYSTEM.

I have but little to add to the illustrations of this system derived from the dissections of *Ter. chilensis*, *Ter. Sowerbii*, and *Ter. psittacea*, in my former Memoir; but figures are subjoined to render its anatomy better understood. Taking the ventral or perforated valve, to which the peduncle is directly attached, as the more fixed point, the *adductores longi* (Pl. i, fig. 2, o, p,) arise from a single pyriform area at the middle of that valve, v, a little behind a line transversely bisecting it; the fibres soon become tendinous, converge, and group themselves into two lateral muscles forming a pair; each of these muscles as it approaches the opposite valve expands and subdivides into an

anterior and posterior portion; glides between the stomach and the crus of the calcareous loop of its own side, and is attached by the double expanded insertion into the dorsal or perforated valve, D: for the anterior division, I propose the name of 'adductor longus anticus,' *o*, for the posterior one, that of 'adductor longus posticus,' *p*; but both of the so-divided adductors, by reason of their ventral confluent attachment, may be regarded as constituting one quadricipital muscle. The action of this complex muscle is directly to close or adduct the valves, in which action it will slightly compress the hepatic lobes and stomach.

The *adductor brevis, ib. q*, forms a symmetrical pair, having their expanded disc of attachment to the ventral valve extended somewhat in advance of the confluent insertion of the preceding muscles: the fibres of each pass obliquely backwards, and converge to a small round shining tendon, the tendons passing on each side the intestine to be inserted close together into the cardinal process of the dorsal valve, D. Their action will be to adduct the valves; but with a more oblique movement bearing upon the ventral valve, V, which they, as it were, help to suspend from the hinge, as from a fixed point.

A third pair of carneo-aponeurotic muscles, *u*, which pass from valve to valve, are attached by both extremities nearer their line of junction, serve to strengthen the hinge, and, by compressing the sides of the base of the peduncle, may aid in protruding that part after it has been forcibly retracted: the muscles in question, which I propose to call '*musculi cardinales*,' or hinge muscles, are attached by their smaller and most tendinous extremity to the linear ridge between the hinge-teeth cavities, fig. 1, p. 9, *b*, and hinge-plate, *ib. c*, in the imperforate valve; they arise by their larger and more fleshy ends from the imperforate valve, close together, behind the common attachment of the *adductores longi*, the rectum alone intervening; some of their fibres appear to be lost upon the sides of the sheath of the peduncle.

The proper muscles of the peduncle consist of two pairs, for its retraction and attachment to the valves; and of some circular or transverse fibres of the sheath, which, though for the most part of an aponeurotic character, appear to be arranged so as to act as compressors and elongators, or protrusors, of the peduncle.

The name *retractor inferior*, pl. i, fig. 2, *s*, is given to a pair of muscles which arise from the ventral valve by a thick carneous end, exterior to the 'adductores longi' and 'brevis:' the fibres pass obliquely backwards, and rapidly diminish to a tendon which penetrates the upper and lateral part of the sheath of the peduncle, and the terminal fibres of which appear to constitute part of the peduncle itself. This pair of muscles serves to suspend the Terebratula by means of the perforated valve to the peduncle, and forms the most direct retractor of that part, and consequently the chief agent in such limited movements, as the fettered state of the shell will allow.

The name '*retractor superior*,' *ib. t*, is applied to a pair of muscles which have a broad subtriangular carneous origin from the hinge-plate, and a strong aponeurosis extending therefrom to the crus of the calcareous loop, *ib.* fig. 3, *t*, *t*: the fibres curve over the sides of

the swollen part of the capsule of the peduncle, penetrate the capsule, interlace with the inserted fibres of the inferior retractor, and terminate for the most part in the peduncle.

Some not very clearly defined, partly carneous, chiefly tendinous, fibres, which interlace, running mostly in the transverse direction upon and in the capsule of the peduncle, and make up, in fact, a chief part of its substance, have a transversely oblong surface of attachment or strong adhesion to the lower part of the bent conical prolongation of the ventral valve lodging the peduncle: this surface appears in the exterior of the soft parts of the Terebratula, behind the origins of the *cardinales* muscles, fig. 2, p. 9, *r'*. I have proposed the name of '*capsularis*,' for the sum of the carneo-tendinous fibres which have the attachment in question. In conjunction with the completely encircling fibres of the peduncular capsule, they must compress and elongate the peduncle.

In addition to the carneo-tendinous fibres arranged in the more or less definite masses above-described, there must be enumerated in the muscular system the double spiral fibres which form the muscular wall of the canal, pl. i, fig. 1, and pl. iii, fig. 2, *z*, traversing the stems of the fringed arms; and the muscular fibres of the pallial lobes, which latter are extremely feebly developed, and recognisable only near the periphery. Thus, to recapitulate the designations of the several muscles in the *Terebratula*, as demonstrated by dissections of the *Ter. chilensis*, *Ter. psittacea*, and *Ter. flavescens*, there may be enumerated the—

Adductor longus anticus,
Adductor longus posticus,
Adductor brevis,
Cardinalis,
Retractor superior,
Retractor inferior,
Capsularis,
Brachial muscles,
Pallial muscles.

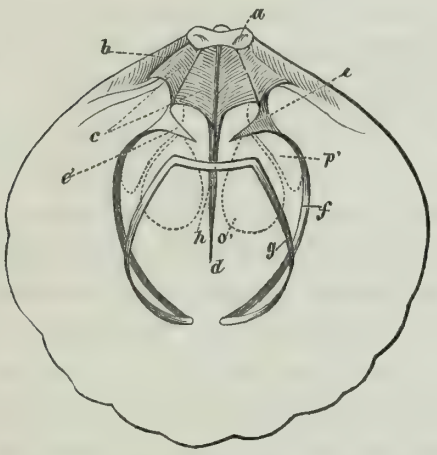
The first seven muscles leave more or less recognisable impressions on the interior of the valves: the marginal muscles of the mantle are too feebly developed to mark the shell, as it is impressed in the Lamellibranchiate bivalves.[1]

In the subjoined cuts the muscular impressions and some other parts of the valves are indicated by the following letters:—Fig. 1 (Dorsal Valve): *a*, cardinal or hinge-process; *b*, depression for hinge-teeth; *c*, hinge-plate; *e*, crus or origin of calcareous loop; *e'*, crural process; *f*, produced plate—*g*, reflected plate—of calcareous loop; *o'*, impression of *adductor longus anticus*; *p'*, impression of *adductor longus posticus*. Fig. 2 (Ventral

[1] Most of the above details of the muscular system were communicated by me to the Meeting of the Italian naturalists at Naples in 1846; and an abstract was left for publication in the 'Annals' of that Meeting.

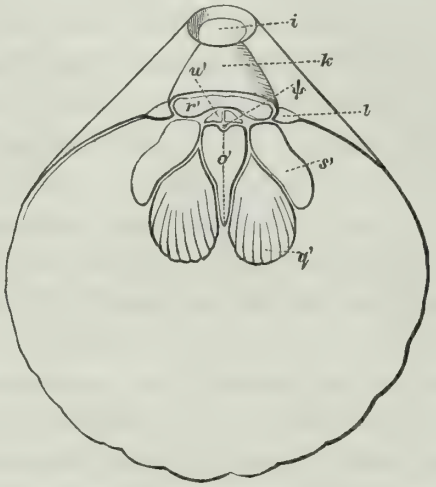
Valve) : *i*, perforation for passage of peduncle ; *k*, accessory shelly piece, called ' thecidium;' *l*, hinge-tooth ; *q'*, impression of *adductor brevis ; s'*, impression of *adductor inferior ; o'*, impression of confluent attachments of the *adductores longi ; u'*, impressions of the *cardinales* or hinge-muscles ; *r'*, impression of the *capsularis ;* ψ, the position of the anus.

Fig. 1.



Inner surface, with calcareous loop, and muscular impressions of the Dorsal Valve, *Terebratula flavescens*, (magn.)

Fig. 2.



Inner surface and muscular impressions of the Ventral Valve, *Terebratula flavescens*, (magn.)

With respect to the fringed arms, I have very little to add to the descriptions in my earlier Memoir. The modifications of the calcareous support—a kind of internal skeleton, fig. 1, p. 9, and pl. 1, fig. 2,—have been fully and accurately detailed by my able colleague, Mr. Davidson, in his communications to the ' Annals and Magazine of Natural History,' and in the Monograph to which the present notes are prefixed. I shall only, therefore, append some remarks on the arrangement of the soft parts supported by the calcified loop, as they exist in the *Terebratula flavescens*. In this, as in other *Terebratulæ*, the fringed portions of the arms are not immediately supported by the loop, this serves only for the attachment of the thin but firm aponeurotic membrane which forms the true basis of support of the beautiful and peculiar organs in question.

The crura, *e*, fig. 1, of the shelly-loop, are attached to the hinge-plates of the dorsal valve : from each crus is continued a produced and a reflected plate, which latter are united by a transverse portion completing the loop : a short descending process, *e'*, is sent off near the basal attachment of each crus. The produced plate, *f*, pl. 1, fig. 2, after advancing forwards to about three fourths of the antero-posterior diameter of the shell, bends towards the ventral valve to form the reflected plate, *g*, and both portions are also bent with their convexities outwards. The brachial aponeurosis, *v*, pl. 3, figs. ii and iii, which incloses the loop and its processes, is continued transversely from one crus to the other, near the hinge, forming the ' basal fold,' *w*, pl. 2, fig. i ; passes from the produced to the reflected plates, binding them closely together, and forming the ' lateral folds,' *a*, *a*, pl. 3, fig. iii ;

is next continued forwards from the basal fold to the transverse end of the loop, and is thence continued forwards, independently of the loop, between the bases of the spiral portions of the arms, uniting the right to the left throughout the extent of the spire, forming the 'spiral fold,' *y*, pl. 2, fig. i, of the brachial aponeurosis.

The basal fold, *w*, pl. 2, fig. i, is perforated by the œsophagus, the mouth opening into the pallial cavity below the beginning of the spiral fold: the alimentary canal bends backwards, over the basal fold, after perforating it; the fold thus intervening between the œsophagus and intestine. The filaments given off from the beginning of the arms, supported by the basal fold, are shorter than the rest. The aponeurosis, reflected from the lateral to the spiral folds, forms the fore-part, *v*, *v*, pl. 3, figs. ii and iii, of the small visceral cavity; the pallial membrane is continued from the union of the lateral with the basal folds, is stretched over the visceral interspace between the advancing crura, and is then continued backwards towards the hinge, protecting the hearts and sinuses behind the transverse fold. The lateral folds decrease in breadth as they advance forwards: the spiral fold, *y*, pl. 2, fig. 1, which, at its beginning, is broader than the broadest part of the lateral folds, gradually becomes narrower as it approaches the termination of the spire. The lamellæ of the several above-defined parts of the aponeurotic supporting and connecting brachial folds, separate when they reach the calcareous plate, *a*, and the hollow muscular stems, *z*, *z*, pl. 3, fig. ii, of the fringed arms, closely surround and adhere to these stems, being continued thence upon the border formed by the roots of the fringe-filaments, where the aponeurotic character is exchanged for that of a delicate membrane, which is finally lost upon the filaments themselves.

The fibres of the muscular walls of the brachial canal, pl. 3, fig. ii, *z*, are beautifully arranged in a decussating double spiral, evidently adapted for compressing the contained fluid, and thereby reacting upon the arm of which the muscular canal forms the base. In the *Terebratulæ*, like *Ter. psittacea*, with free multispiral brachia, the fluid of the canal being acted upon by the spirally-disposed muscles composing its parietes, is forcibly injected towards the extremity of the arm, which is thus unfolded and protruded outwards. In the species resembling *Ter. flavescens*, the spiral portion may also be, in like manner, so far unfolded as to react upon the closed valves of the shell.

What power the animal may possess of further unfolding and protruding the free extremity of the united spiral portions of the arms, can only be determined after careful observation of the living *Terebratulæ* in their native localities. The structure of the parts in question led me to note, in 1833, the important difference between *Lingula* and those species of *Terebratula* which resemble *Ter. chilensis* in the structure of the arms, "since, from their attachments, they are fixed and cannot be unfolded outwards as in *Lingula*."[1] Mr. Davidson has expressed a similar opinion in his comprehensive and able "Classification of recent Brachiopoda,"[2] in reference to the spiral portion of the fringed arms;

[1] Zool. Trans., vol. i, p. 149.

[2] Annals and Mag. of Nat. Hist., t. ix, 2d ser., 1852, p. 363.

observing with respect to the *Ter. australis*, *Ter. vitrea*, and other species of his genus *Terebratula* proper, that, "from its texture and relations it never could be moved or unrolled at the will of the animal;" and he adds, "the sole use of the folding of the arms is to give increased surface for the disposition of the cilia." By the latter term, the author means what I have here and elsewhere called the 'filaments,' forming the fringe. But comparison of the parts in action of a living Mollusk, with the same parts in a dead specimen stiffened in alcohol, has in most cases tended greatly to expand the observer's notions of the powers and uses of such parts derived from dissections; and it would be rash to conclude that so well-organised and beautiful a mechanism for acting on the fringed arms in the direction of their length, as is shown in figures ii, pl. 2, and ii, pl. 3, should exist there without a purpose, as would be the case were the folding of the arms solely for the purpose of augmenting the surface for the attachment of the filaments. In my earlier Memoir, while appreciating and admitting the great difference in the arrangement of the arms for the facilitating their movements of extension, in different species of *Terebratulæ*, since raised to the rank of genera, other uses of the foldings of the loops had also suggested themselves. "The muscular stem, by means of its attachment to the calcareous loop has the power of acting upon that part to the extent its elasticity admits of, which is sufficient to produce such a degree of convexity in the reflected part of the loop, as to cause it to press upon the perforated valve, and separate it slightly from the opposite one."[1] Observations on living Mollusks are, however, essential to the formation of adequate and exact ideas of the uses of parts of the several muscular parts of their organisation.

The fringe-filaments, γ, δ, pl. 3, figs. ii and iii, of the produced and reflected portions of the brachia, are in a single series; they are compressed, very narrow, close set, with their flat sides towards each other, very gradually tapering to the extremity which is slightly bent, the rest of the filament being usually straight: those, ε, of the spirally-disposed portion are split at the end, and the split is deeper as the filaments are situated nearer the end of the spire, where they appear thereby to be arranged in a double row. In most specimens, the filaments of the spire incline towards each other, and meet at their extremities, inclosing a triangular space, as shown in pl. 3, fig. ii, in which the end of the spire has been cut off.

NERVOUS SYSTEM.

The nervous system of the Terebratula consists of three principal parts or systems, the "pallial," "brachial," and "visceral." The roots or origins of these three systems centre in the œsophageal ring, ξ, pl. 2, fig. i.

This annular centre is situated in and defended by the basal fold of the brachial aponeurosis, *ib.* w, surrounding the aperture by which the œsophagus penetrates the visceral chamber. A few very delicate filaments pass off from the part of the ring which is turned

[1] Tom. cit., p. 150.

towards the aperture of the shell, and which part, from the downward bend of the mouth, is made anterior, instead of being, as in the normal position of the mouth, dorsal. These filaments are lost in the beginning of the spiral connecting fold, *w*, *y*, the brachial spire thus receiving some of their nerves from the same part of the œsophageal ring, as the antennæ do in insects, and the cephalic tentacula in the higher Mollusks. The two chief nerve-trunks from the ring, ξ, figs. i and ii, come off from its lower and lateral angles, a very slight swelling, hardly to be called a ganglion, occurring at their origin. Each of these trunks quickly divides, one division, ι, going to the mantle, the other, π, penetrating the base of the fringed arm of its own side. The pallial trunk is the largest; it soon divides to supply the upper and lower mantle-lobes of its own side: the course of that distributed upon the dorsal lobe is shown in pl. 2, fig. ii.

The dorso-pallial nerve, μ, extends a short way upon it, and then expands into what appears to be an oblong narrow ganglion; but which is a loop formed by the slight divarication and reunion of the fibres of the trunk. From this loop, ν, most of the pallial filaments diverge. In their course towards the margin of the lobe they cross obliquely the great pallial sinus, and give off branches, ξ′ most of which correspond with the branches of the sinus, these branches subdividing, and their ramifications appearing to unite in a common circumpallial nerve, ο, which runs along the inserted bases of the marginal cilia. The brachial nerves, π, fig. 1, may be traced some way along the muscular canal of the fringed arms.

Two delicate filaments which traverse part of the visceral chamber come off from the lower part of the œsophageal circle near the origins of the great pallio-brachial trunks; they probably supply the muscles which traverse the visceral chamber, as well as the hearts and alimentary canal; but the indications of this part of the system were too faint and uncertain, in *Terebratula*, for safe depiction.

In *Lingula* they are more distinct, and are shown in fig. iii. The nerves, marked ρ, come off from the subœsophageal ganglion, diverge as they pass backwards along the visceral chamber, then converge to their insertion in the anterior muscles. The nerves, σ, come off directly from the subœsophageal ganglions, and run more parallel as they pass along the ventral aspect of the anterior muscles to go to the posterior muscles. More delicate filaments pass to the alimentary canal and the hearts. *Lingula* has also the pallial and brachial systems of nerves as well developed as in *Terebratula*. I have not been able to detect any traces of special sense-organs in the *Brachiopoda*.

DIGESTIVE SYSTEM.

The mouth, pl. 1, figs. 1 and 4, τ, of the Terebratula, opening downwards, as before remarked, at the base or beginning of the passage formed by the spiral brachial fold and the converging fringes of the brachial spire, has a tumid and sub-bilobed upper or anterior lip, and a thinner and broader lower or posterior lip, which is attached to the

basal portion of the fringed arms uniting the central portions. The swollen margins of the mouth are formed by both muscular fibres and secerning cells: there are no rudiments of a maxillary or dental apparatus. The organic molecules subserving the nutrition of the *Brachiopoda* are brought by ciliary action within reach of the mouth, are there seized and swallowed. The œsophagus, υ, is short, of uniform diameter, has a delicate membranous outer tunic, a muscular coat, and a thicker epithelial lining than that of the rest of the alimentary canal. It inclines slightly forward as it ascends, between the anterior portions of the liver, to terminate in the stomach: it is slightly constricted at its termination, *ib.* fig. 4: there is no valvular structure at the cardiac aperture. The stomach, ϕ, is a simple oblong cavity, swelling out slightly at the cardiac end, where it receives the biliary secretion, continuing thence for some way of the same diameter, which is rather more than half its length; and gradually contracting to the pylorus. Its tunics consist of an outer membranous, a muscular, and a smooth inner mucous, coat, the epithelium of which is more delicate than in the œsophagus. The whole cavity is bent down at an acute angle with the œsophagus, and the cardiac half is buried in the large granular liver, *ib.* fig. 1, ω. There is no valvular structure at the pylorus: but in some specimens it presented a slight circular constriction. The intestine, χ, is short, straight, and is continued downwards and a little backwards, in a line with the pyloric part of the stomach to the interspace between the attachments of the adductores longi and cardinales to the ventral valve, where the minute vent, ψ, opens into the pallial cavity, *ib.* fig. 1. It does not perforate the capsule of the pedicle. The fæces are carried out by the pallial and brachial currents. The intestine is enveloped to within a very short distance of the vent by an extremely delicate venous sinus, pl. 3, fig. 1, 8, the outer wall of which is connected with the plicated auricles, *ib.* 1, 1, situated one on each side of the gut, a little above its middle. The muscular tunic of the intestine presents the same uniform thickness as that of the stomach. The muco-epithelial lining membranes are disposed in very delicate transverse plaits, pl. 1, fig. 4, χ.

The liver, ω, is about three times the bulk of the stomach, and forms the most conspicuous of the chylopoietic viscera, when the abdominal cavity is exposed. It consists of very numerous ramified follicles, the terminal ones of which are of equal size, and their round closed ends give the apparently granular exterior surface to the gland: the intimate structure of the hepatic follicles in *Ter. flavescens*, agrees with that described in my earlier Memoir, in *Ter. psittacea* and *Ter. chilensis*. There is no natural division into lobes; a slight pressure suffices to displace groups of follicles, which then assume the lobular character. The ducts form the common stems of the manifold ramifications, and they are usually two in number, communicating, each by a distinct aperture, with the cardiac end of the stomach. The liver, as in other Mollusks, is supplied by ramifications of a hepatic artery, the blood thence passing into veins which speedily expand into wide shapeless sinuses, communicating, like the intestinal sinus, with the plicated auricles.

VASCULAR SYSTEM.

The vascular system of the *Brachiopoda* is peculiarly well adapted to demonstrate that remarkable condition of the venous system in the Molluscous class which, when first and somewhat imperfectly observed, gave rise to the idea of the blood being extravasated into the lacunæ of the viscera, and the interstices of other soft parts and tissues. It was on that account that I was induced to communicate a note, with a few illustrations of the real state of the venous system, as exemplified in the *Terebratula* and *Lingula*, to my esteemed and distinguished friend and colleague in the French Academy of Sciences, Dr. Milne Edwards, whose descriptions of an analogous condition of the venous system discovered by him in other Mollusks might have been interpreted, through the ambiguity of certain terms and expressions, as giving countenance to the theory of extravasation, which had been at that time propounded under the term 'phlebenterism.' In the Number of the 'Annales des Sciences Naturelles' for March 1845, *e. g.*, M. Edwards, in his 'Report on the Results of a Voyage to Sicily,' writes "Chez les Mollusques, même les plus parfaits, le système des vaisseaux à l'aide desquels le sang circule dans l'économie est plus ou moins incomplet; de sorte que, dans certains points du cercle circulatoire, ce liquide s'épanche dans les grandes cavités du corps ou dans les lacunes dont la substance des tissues est creusée." —p. 139. Mere words rarely turn men from wrong opinions, at least in a science of observation; but a step, I thought, would be gained in the right direction, if the things, with what might be their more correct interpretation and designations, were placed before the eyes of the accomplished author above cited. The desired result was not, however, attained; for, in a subsequent number of the 'Annales des Sciences,' May, 1845, p. 292, in which my Paper 'On the Circulation of the Brachiopoda' appeared, the able Editor reproduces his former statement in reference to the circulation in the Mollusks; and, by way of contrast with what he continued to regard as the less correct view, he proceeds to remark: "Effectivement, dans les ouvrages les plus récents sur ces matières, on dit que cet appareil est *un système de vaisseaux clos dans lequel le sang de tout le corps est enfermé:*" reference being made to 'Owen, Lectures on Comparative Anatomy and Physiology of the Invertebrate Animals,' p. 13, London, 1843.

I believe, however, that it is now admitted by most, if not all Malacologists, that a system of arteries and veins is not the less 'a closed and continuous system of circulation,' because the veins exchange their cylindrical for less regular forms, with a concomitant evanescence of all the coats save the innermost tunica propria.

Such is the condition of the major part of the venous system in the *Terebratulæ*. The hearts are two in number, and distinct; they consist, as in other Brachiopoda, each of an auricle and a ventricle, and are situated, in the *Ter. flavescens*, at the back part of the visceral cavity, on the dorsal aspect of the intestine, one on each side of its upper or anterior half.

If the dorsal valve and corresponding lobe of the mantle be removed, as in pl. 3, fig. iii, and the 'musculi retractores superiores,' *t*, be gently divaricated, or the mesial fasciculi carefully removed, as in fig. ii, the delicate membrane of the venous sinuses, *ib.* fig. ii, 7, and fig. i, 6, communicating with and closing the basal apertures of the auricles, 1, is immediately exposed; and is so transparent as to permit the plicated structure of those cavities to be clearly seen.

If the viscera be exposed by a side view, as in pl. 1, fig. 1, the heart of the side exposed will be seen behind the beginning of the intestine, as at 1, fig. 1.

The ventricle, 2, pl. 3, fig. 1, in each heart, is a smooth oval feebly-muscular cavity, which transmits the blood by two arteries,—the largest to the two halves of the mantle-lobes nearest the ventricle, the smallest to the viscera and muscles. In the mantle the arteries terminate at the periphery in the circum-pallial vein or sinus, 4, pl. 2, fig. ii, from which the branches, *ib.* 5, 5, of the large pallial sinuses commence. These sinuses, although the cylindrical is exchanged for a flattened depressed figure, retain enough of the more normal character of the veins to be recognised distinctly as such. There are two of these branched sinuses, 5, in the dorsal lobe, or that which lines the imperforate valve, and four, 6, in the ventral lobe, or that which lines the perforated valve. Their longitudinal course and relative positions so closely correspond with those which I have described and figured in *Terebratula chilensis*,[1] as to preclude the necessity of repeating either description or figures in this place. The two sinuses in each half of the ventral lobe unite into one, and this trunk unites with the base of the single sinus of the corresponding half of the opposite mantle lobe; the common sinus, so formed, at the back part of the visceral chamber receiving the venous blood from other sinuses there that fill, line, and seem to form, the visceral or peritoneal cavity. The common sinus so constituted, on each side of the intestine, terminates by being continued into the margin of what seems to be the widely-open auricle, as seen through the transparent parietes of the sinus, 1, pl. 3, fig. 1. The auricular cavity would, however, be more correctly described as a closed one, consisting at the half next the ventricle of a beautifully plicated muscular coat, in addition to the membranous one, but at the other half, next the venous sinuses, of venous membrane only: the latter might be termed the auricular sinus, the former the auricle proper. The proper auricle, then, *ib.* 1, 1, presents the form of an oblong depressed cone, attached by its apex to the ventricle, the apex being penetrated by the auriculo-ventricular aperture, and adherent by its base to the auricular sinus, which might be said to conduct into the common peritoneal cavity, since the delicate tunics of the visceral sinuses appear to take the place of a peritoneum. The muscular walls of the auricles are thin and delicate, but exhibit two layers of fibres, the exterior ones being disposed transversely or circularly, the interior ones longitudinally, the latter being the most delicate and radiating from round the perforated apex to the plicated circumference of the auricle. These muscular walls are beautifully disposed in

[1] Tom. cit., pp. 147, 148, pl. xxii, figs. 5 and 6.

small plaits or folds, also radiating from the apex: and the longitudinal or radiating folds are puckered by transverse folds, 1, pl. 3, fig. 1. The figures ii and iii, pl. 3, which are magnified to the same degree, exemplify two of the different states in which the plicated auricles, 1, are found in different individuals, and so far exemplify the extent of dilatation and contraction of which these complex cavities are susceptible; but they have presented more extreme differences of size in other specimens, and they must possess considerable powers of altering their capacity. It is, therefore, probable, that, when the circulating fluid is accumulated in unusual quantity in the pallial and visceral sinuses, the longitudinal auricular fibres evert and expand the margins of the basal aperture to which the delicate tunic of the sinuses is attached, as shown in fig. 1, 1, 5, 6, that the fluid is drawn by a kind of vermicular movement or peristaltic suction into the auricles, 1, 1, and is thence propelled by successive contraction of the circular fibres into the ventricles, 2, 2. From the ventricles the blood is driven through the ramifications of the pallial and visceral arteries again into the more or less irregular and capacious sinuses, and so returns slowly back to the heart. In this circulation there is no actual extravasation: I find, after the most patient scrutiny, no evidence of an escape of the blood into mere lacunæ or interspaces excavated in the tissues of other and surrounding systems; but the result of such scrutiny has been, invariably, the detection of the continuation and expansion of the proper tunic of the veins into such seeming lacunæ or interspaces. And although, in the wide clefts between the viscera and muscles in the abdominal chamber, the tunic of the venous sinuses is disposed like a peritoneum, seems to perform, also, the function of a peritoneum, and the contained fluid, that of peritoneal serum, in addition to their own more proper and important offices, —and although an anatomist might be permitted, by such similarity of function, to call the cavities of the sinuses 'intervisceral lacunæ,' and the walls of the sinuses 'peritoneum,' —yet, if he were guided in his nomenclature by considerations of homology instead of analogy, he would more correctly term them 'abdominal venous sinuses' and 'venous tunic' respectively. In either case, as a matter of fact, there is no real or essential departure from a circulation in a closed system of arteries and veins; but only a morphological departure from the typical character of the organs of circulation,—an extreme one, it is true, but little likely to lead astray the zootomist who had been prepared for such formal modifications of the vascular system by the discoveries of Hunter, as they are manifested in his preparations, and by the descriptions and figures of such preparations, of the venous system in the classes of Insects and Crustaceans.

As these clearly enunciated discoveries have been overlooked by the continental Physiologists, who have been stimulated by recent discussions on 'phlebenterism' to take a retrospect of the history of the progress of anatomical research in the field of the vascular system of the Invertebrata,[1] it may not be without its use, and it is but a mere act of justice to our own great anatomist, to call attention here to his interpretation of

[1] Rapport sur Phlébentérisme, par M. le Dr. Robin, 8vo, 1851.

the facts which have recently misled some otherwise valuable labourers in that field, into phlebenteric notions.

"In the winged insects, which have but one heart, as also but one circulation, there is this heart answering both purposes, (viz., the corporeal and pulmonary circulations)." (Hunter on the 'Blood and Inflammation,' 4to, 1796, p. 134.) "When the veins entering into the heart are small, in comparison with the quantity of blood which is wanted in the ventricles, there we have an auricle; but where the veins near the heart are large, there is no auricle, as in the lobster, and generally in insects. In the snail, where the veins in common are large, yet as they are small where they enter the heart, there is an auricle." (Op. cit., p. 138.) But what, it may be asked, did Hunter mean by "large veins" in insects, the lobster, and the snail. He has left us the explanation of his meaning in his observations 'On the Circulation in Insects,' where he writes:—

"OF THE VEINS."

"The veins of the insect would appear to be simply the cellular membrane; but they are regularly formed canals, although not so distinctly cylindrical canals, as in the quadruped, &c., nor branching with that regularity. They would appear to be, or to fill up, the interstices of the flakes of fat, air-cells, muscles, &c., and, therefore, might be called, in some measure, the cellular membrane of the parts." ('Hunterian MS. Catalogue,' printed in the 'Physiological Catalogue,' tom. ii, p. 31, (1834.)

Baron Cuvier, as is well known, entertained with regard to the vascular system of Insects, ideas closely akin to those which some of his pupils have more recently expressed by 'phlebenterism,' after modifying M. Quatrefage's original meaning of the term; for Cuvier supposed that the whole of the blood of Insects stagnated in the lacunæ or cellular interspaces of the several organs: he was consequently led to deny that insects possessed a true circulation, or that the dorsal tube—"heart, extending through the whole length of the animal," (Hunter, op. cit., 1793, p. 137,) acted as a heart. The more truthful views of Hunter, based on the analogy of the already commencing irregularity and extent of the venous sinuses in the lobster and snail, have been amply confirmed by the researches of Professor Carus, on the 'Circulation of the Blood in the larvæ of Ephemerides and Libellulæ.'[1]

With regard to the Crustacea, Hunter, who left preparations, and a beautiful series of drawings, illustrative of the circulating system in the Lobster (*Astacus marinus*), thus describes the latter:—

"OF THE VEINS IN THE LOBSTER.

"The veins in this class of animals, as in the winged Insect, &c., are principally in the form of large irregular cells, as if the cellular or investing membrane of the animal contained the venal blood; and, when injected, we find the injection principally in large

[1] Blutkreislaufes in den Larven netzflüglicher Insekten, 4to, 1827.

masses." He then, referring to his figures, describes the different sinuses, as "*a*, a large mass of vein, lying on the stomach: *b*, another mass similar to the above, lying principally on the heart, which might almost be considered an auricle, as from it are openings into the ventricle." (Hunterian MSS., in 'Physiological Catalogue of the Museum of the Royal College of Surgeons,' vol. ii, 1834, p. 138.)

The conditions of the vascular system in insects, crustaceans, and the snail, enunciated in brief but clear general terms in the work 'On the Blood,' 4to, 1793, and exemplified by preparations, drawings, and manuscript descriptions left by Hunter in his museum, at his demise in the same year, appear to have passed unappreciated abroad, until the successive discoveries of analogous structures in other invertebrata, or the rediscovery of the same structures in the same species which Hunter had dissected, had been made.

Baron Cuvier appears to have been the first to recall the attention of comparative anatomists to this diffused and expanded condition of the venous system in his dissection of the *Aplysia;* but he mistook the expanded sinuses which fill the abdominal cavity, like those in the Terebratulæ, for that cavity itself. Describing the 'venæ cavæ,' which perform the office of the branchial arteries, he writes:—"Leurs parois se trouvent formées de rubans musculaires transverses et obliques, qui se croisent en toutes sortes de sens, mais qui laissent entre eux des ouvertures sensible à l'œil, et encore plus à toutes les espèces d'injections, et qui établissent une communication libre entre ces vaisseaux et la cavité de l'abdomen; de manière que les fluides contenues dans celui-ci pénètrent aisément dans ceux-la, et réciproquement."—"Il résulte toujours que les fluides épanchés dans la cavité abdominale peuvent se mêler directement dans la masse du sang et être portés aux branchées et que les veines font l'office des vaisseaux absorbants. Cette vaste communication est sans doute un première acheminement à celle bien plus vaste encore que la nature a établie dans les insectes, où il n'y a pas mêmes de vaisseaux particuliers pour le fluide nouricier,"[1] (pp. 299, 300.)

Jurine, in 1806, observing living specimens of a minute crustacean (*Argulus foliaceus*) which were asphyxiated by a few drops of alcohol added to the water they were in, traced the course of the circulation, which he describes, remarking:—J'ai evité d'employer le mot *vaisseau* pour désigner les conduits dans lesquels le sang circule, et que j'ai remplacé ce mot, tantôt par celui de *colonne*, tantôt par celui de *rameau*. Les raisons qui m'ont engagé à le faire reposent sur la manière dont s'opère cette circulation. En effet, le sang chassé dans la partie antérieure du teste paroît s'y répandre et s'y disséminer de manière à faire croire que les globules sanguins sont dispersés dans le parenchyme de ces parties, plutôt que d'être contenus dans des vaisseaux particulières. Je ferai cependant observer qu'il existe dans ce liquide quatre espèces de courans qui ferment les quatre rameaux dont j'ai parlé plus haut, et que, dans les ailes comme dans le queue, la circulation ne se fait pas d'une manière aussi diffuse que dans la partie antérieure du

[1] Mémoire sur le Genre *Aplysia*, &c., in 'Annales du Muséum,' tom. ii, 1803, p. 287.

teste, le liquide globuleux paroissant y être renfermé dans une espèce de large canal pratiqué dans le parenchyme de ces parties." (p. 439.)[1]

It was, probably, owing to the misinterpretation of the remarkable facts which Cuvier had observed, that Meckel, notwithstanding the analogous structures, in the meanwhile pointed out by Jurine in the *Argulus*, and by Gaspard[2] in the *Helix pomatia*, was led to deny the existence of the apertures of communication observed by Cuvier in the large muscular venæ cavæ of the Aplysia. In 1832, however, I detected a structure in the venous system in the *Nautilus Pompilius*, closely analogous to that which Cuvier had pointed out in the Aplysia: but, having traced the continuity of the proper lining tunic of the great muscular vena cava, through the apertures in that coat, with a similar membrane lining the abdominal cavity, I was led to describe the tunic of the abdominal sinus as the peritoneum. "There are several small intervals left between the muscular fibres and corresponding round apertures in the membrane of the vein and in the peritoneum, so that the latter membrane is continuous with the lining membrane of the vein."[3] And, after referring to the analogous structure in the Aplysia, I add that this correspondence leads to the "suspicion that it may be more generally found on a further and more diligent investigation of the venous system in this remarkable class of animals."

Ten years later, M. Pouchet,[4] Professor of Zoology at Rouen, demonstrated in *Limax*, a structure answerable to that which M. Gaspard had described in *Helix*: viz., that the blood passed from the arterial capillaries into the visceral cavity, whence it was received by particular orifices into the veins that carried it directly to the pulmonary chamber, ramifying there like a 'vena portæ' before returning to the heart.

In 1834, the same year in which I edited the figures and descriptions by Hunter of the Circulating System in the Lobster, M. Milne Edwards recorded his examination of the same system in the same species, in the 'Histoire Naturelle des Crustacés,' vol. i, p. 101. He there describes the expanded venous sinuses, as "plutôt des lacunes situeés entre les divers organes que des canaux à parois bien formées." (Op. cit., p. 102.) The term 'lacunes' is also adopted for that of 'venous sinuses' by the Editor of the posthumous edition of the 'Leçons d'Anatomie Comparé of Cuvier,' t. vi, 1839, pp. 504, 505.

In 1843, M. Quatrefages[5] believed that he had discovered a Mollusk, his *Eolidina paradoxum*, in which the organs of circulation were reduced to a univentricular heart and a system of arteries. "Le système veineux," he writes, "manque entièrement. Il est en quelque sorte remplacé par des lacunes du tissu aréolaire." In the same nudibranchiate

[1] Sur l'*Argule foliacé*, in 'Annales du Muséum,' tom. vii, p. 431, 1806.

[2] Recherches sur la Physiologie de l'Escargot des Vignes (*Helix pomatia*), 'Journal de Physiol. de Magendie,' 1822, t. ii, p. 295.

[3] Owen, on the Pearly Nautilus, &c., 4to, 1832, p. 28.

[4] Recherches sur l'Anat. et la Physiol. des Mollusques, 4to; Rouen, 1841.

[5] Annales des Sciences Nat., 1843, t. xix, Comptes Rendus, 1843, p. 1124.

the ramifications of the alimentary canal are also described as penetrating the branchiæ, "where the chyle was directly submitted to the atmospheric influence exercised by the surrounding water." To this supposed condition of the digestive, circulating, and respiratory systems, he gave the name, 'Phlebenterism,' and proposed thereon some corresponding changes in the classification of the mollusca.

In the 'Report' on this and other memoirs of M. Quatrefages on the Nudibranchiate Mollusks, by M. Milne Edwards, that distinguished professor adopts the mode of interpreting the modification of the venous system, and applies it to the Crustacea. "Il existe" (dans le genre Eolidine) un cœur et des artéres bien constitués, mais pas des veines proprement dites, et le sang ne revient des divers parties du corps que par un système des lacunes irregulières, disposition tout-à-fait analogue à celle dont les Crustacées nous avaient deja fourni un example. Enfin dans d'autres espèces, que M. Quatrefages a dêcouverte sur les côtes de la Bretagne, le cœur et les artères disparaissent à leur tour; de sorte que la circulation devient des plus incomplètes et resemblent à celle qu'on apperçoit chez les Bryoozoaires." Subsequent researches by Messrs. Embledon and Hancock demonstrated, however, the existence in the genera *Chalide* and *Actéonie*, of both heart and arteries; and the same careful anatomists confirm the observations of M. Souleyet,[1] that the veins were not wanting in the nudibranchs, but had only undergone that modification of form to which the term sinuses is more properly given. Not any of these authors have, however, published exact and recognisable representations of the relations of the attenuated tunica propria of the veins, to the interspaces or laminæ which that tunic lines in forming the large and irregular sinuses in which the blood is diffused. With a view of supplying this desideratum, further illustrations of the circulating system of the Brachiopoda are added here to those which were published in my earlier memoirs.[2] Figure 1, pl. 3, more especially will show that the venous system of the *Terebratula*, like that of other mollusks, is continuous, *i. e.* forms a part by continuity of tissue, with the rest of the circulating system. Thus all ulterior researches rightly interpreted, since the time of Hunter, have served to confirm and establish the accuracy of his appreciation and explanation of the facts he discovered in insects and crustaceans, and to extend our knowledge of the same modification of the venous system as it exists in the general series of mollusks.

The absorbent system, as Cuvier truly states,[3] is wanting in mollusks. In the comparatively low organised form under consideration (*Terebratula*), the chyle or product of digestion must transude through the intestinal tunics into the intestinal sinus, pl. 3, fig. 1, 8: all the fluid answering to lymph, from other parts of the organization will be

[1] Observations sur les Mollusques Gasteropodes désignés sous le nom de 'Phlebentères' par M. de Quatrefages; Comptes Rendus des Sciences, &c., 1844, t. xix, p. 355.

[2] Trans. Zool. Soc., 1833, pl. xxii, figs. 7, 8, 11; pl. xxiii, figs. 11, 16.—Annales des Sciences Nat., pl. iv, figs. 8, 9, and 10.

[3] Tom. cit., p. 300.

received into the intervisceral, 9, intermuscular and pallial, 5, 6, sinuses, which will perform the double but closely allied functions of veins and absorbents.

The streams of sea-water excited and maintained by the complex ciliated structure of the mantle, will effect the requisite respiratory changes as they course over the delicately coated, branched, sinuses of the pallial lobes; these, therefore, form the chief seat of the breathing function; but, wherever similar currents come in contact with the vascular system, to that extent the respiratory operations will be diffused.

GENERATIVE SYSTEM.

The generative organs have presented the same form in all the individuals of the different species of *Terebratulæ* examined by me. This form corresponds with that of the pallial sinuses in which they seem to be situated. The figures 15 and 16 *r*, *r*, pl. 22, 'Zool. Trans. vol. I,' from the *Terebratula Sowerbii*, represent so closely the general form and disposition of the same organs in *Terebratula flavescens*, that it seems needless to repeat the figures of them in the latter species.

I have observed, however, a manifest difference of texture and colour in the generative organs of different individuals of *Ter. flavescens* collected at the same period in the neighbourhood of Port Jackson, by my friend Mr. George Bennett, F.L.S., and transmitted in the same preserving liquid. In some specimens the organs are better defined, more compact, and of a paler colour: in others the organs are broader or more diffused, and of a deeper yellow colour.

On a microscopic examination of the first kind, they are found to consist of an aggregate of minute cells, closely resembling those in the half mature testes of the common oyster. I conclude, therefore, that they are the male generative organ in the *Terebratulæ*, and that the individuals of this genus are diœcious, not, as I formerly supposed, simple hermaphrodites. The true ova are very plainly manifested in the broader and deeper-coloured dendritic organs. They are developed, like the sperm-cells, between the outer layer of the mantle and the delicate tunic of the venous sinus, and protrude into that cavity, pushing its lining membrane inwards. The generative organs, in the male, as in the female, developed in the ventral lobe of the mantle, commence—if we may term the part next the hinge of the shell their beginning—by a loop, pl. 3, fig. 1, 12, on each side of that lobe, situated at the point of bifurcation of the two sinuses; these loops are shown in fig. 1, pl. 3, the inner layer of the mantle with the adherent tunic of the sinus being reflected to show the looped portions of the ovaria, 12, 12. In the dorsal lobe the generative organ commences at about the same distance from the hinge, by a simple obtuse extremity; and follows, as it advances, the ramifications of the sinus in which it is lodged. There are thus four distinct ovaria or testes; two in each mantle lobe; those of the ventral lobe being doubled, or bent upon themselves, near the cardinal attached border of the lobe. It may be presumed that the embryos developed under the influence of their suspension in the

aerated and nutrient fluids of the pallial sinuses, escape at a certain stage of that development, by dehiscence, at or near the free ciliated border of the pallial lobes. The course and phenomena of this development would form a most interesting and acceptable subject to a competent microscopical observer favorably situated for pursuing it throughout the breeding season of the *Terebratulæ*.

I subjoin a few stages observed in ova taken from the ramified ovarium of a *Lingula*, preserved in spirits.

Pl. 1, fig. 7, *a*, is an impregnated ovum, in which the germinal vesicle or vesicles have disappeared, and the germ-mass has been formed, occupying the entire ovum, which has assumed an oblong form, a peripheral stratum of the derivative germ-cells was more compact and of a somewhat lighter colour than the central mass.

b, shows the formation of a smooth membrane, probably covered by ciliated epithelium, around the germ-mass.

c, is a transverse section of such an ovum showing its triedral figure.

d, is an ovum further advanced, with the rudiment of a peduncle.

e, an embryo with the peduncle more produced. I could distinguish no organs in these embryos of the *Lingula:* there was no trace of shell.

The dissections from which Mr. Scharf's drawings, engraved in the subjoined plates, were taken, were prepared by my former anatomical assistant, Mr. Henry Goadby, to whose skill in the manipulation of minute objects I am more especially indebted for the demonstration of the nervous system, as shown in figs. 1 and 2, pl. 2.

CHAPTER II.

ON THE INTIMATE STRUCTURE OF THE SHELLS OF BRACHIOPODA.

BY PROFESSOR CARPENTER, M.D., F.R.S., &c. &c.

The shells of the Brachiopoda, whether recent or fossil, present most interesting subjects for microscopical investigation; their structure being, in almost every instance, quite distinct from that of the shells of the Lamellibranchiata, or Gasteropoda, and being so characteristic, that even minute fragments may be referred with certainty to this group, unless their texture has been altered by metamorphic action. Such action appears to have so constantly taken place in the shells preserved in the Palæozoic rocks, that, with regard to some of those genera which are limited to that series, such as *Pentamerus*, *Calceola*, or *Productus*, it is impossible to say with positive certainty how far their structure is conformable to the general type of the group, since this is but very obscurely shadowed forth in them. But, since we find *Terebratulæ*, *Rhynconellæ*, and *Spirifers* of those formations presenting the very same deficiency in characteristic structure with that which is encountered among the genera previously named, we seem fully entitled to affirm, that the absence of such structure in the *fossils* of the strictly-Palæozoic genera is not to be taken as any indication that the *living* shells departed from the general type; whilst, on the other hand, the perfect conformity to that type, of such structure as *can* be distinguished in them, is a positive indication that the shells of these genera were constructed upon the same plan with those of the existing Brachiopoda, as their other affinities would render probable. The following statements, then, which are chiefly based on the examination of *recent* Brachiopoda, may be considered to apply equally to the *extinct*, until any proof shall have been given to the contrary.

There is not, in the shells of Brachiopoda, that distinction between the *outer* and *inner* layers, either in structure or mode of growth, which prevails among the ordinary bivalves; and it seems obvious, both from the nature of the shell substance, and from the mode in which it is extended, that the whole thickness of the Brachiopod shell corresponds with the outer layer only in the Lamellibranchiata, (Pl. IV, fig. 1.) For, as will be presently shown, it must be regarded in the light of a *calcified epidermis*, like the prismatic external layer of Pinna or Avicula;[1] and it is augmented by an addition *to its*

[1] See the author's Memoir on the Microscopic Structure of Shells, in the Report of the British Association for 1844, p. 6.

margin (as seen at *a a*, *b b*, *c c*), as is the case with the outer layer of Lamellibranchiate shells generally, whilst *their* inner layer, formed by the calcification of the basement-membrane of the mantles, is augmented by the interposition of new lamina between the animal and *the whole previous external surface* of the shell, such new lamina being extended beyond the preceding so long as the shell continues to grow, and bearing on its projecting part the marginal addition which has been made to the external layer.[1] I have occasionally met with a second layer, in recent *Terebratulæ*, within the earlier-formed portion of the shell, but confined to only a part of the surface, instead of extending beyond it. Such a layer (represented at Pl. IV, fig. 1, *d d*,) is of precisely the same texture with the remainders of the shell, and appears to be simply destined to afford a mechanical support which its older portion may require, when this has been greatly extended by new growths. Several such layers present themselves in the shell of *Crania* (Pl. V, fig. 8), whose upper valve is formed upon the plan of that of Patella, and is increased, both in thickness and diameter, by new formations successively added to the internal surface, and extending beyond the margins of the old. A like succession of layers, moreover, is easily to be distinguished in the massive shells of many fossil Gasteropoda, in consequence of their ready separation from one another; but in these, as in the preceding cases, they are all repetitions of the first or outermost layer, and do not present any of that difference in intimate texture which almost invariably distinguishes the inner and outer layers in Lamellibranchiate shells. Moreover, in all those Brachiopodous shells which are perforated by the vascular (?) canals presently to be described, the layers are alike perforated by them, although the passages are usually much smaller in the internal or last-formed layers than they are in the outer and older, as is well seen in the portion of the shell of Terebratula delineated in Pl. IV, fig. 3. And when the passages themselves are large, as happens in the internal layers of the shell of Crania (Pl. V, fig. 8), their openings upon the inner surface are frequently so small as to escape observation, when it is examined with a hand-magnifier only.[2]

The "lines of growth" which are so obvious on the external surfaces of the shells of many Brachiopoda do not by any means constantly correspond with interruptions in continuity of structure as displayed in vertical sections of the shell; thus in Pl. I, fig. 1, there is seen at *c* such an inequality of surface as appears to indicate a marginal addition, yet the real extension, as marked by the line *c c*, appears to have taken place at some little

[1] Op. cit., 1847.

[2] It is apparently from observations of this kind, that Mr. Daniel Sharpe has stated, in his account of the Genus *Trematis* (Quarterly Journal of the Geological Society, vol. iv, p. 67), that "an inner layer of unpunctuated shell lining an outer punctuated layer, is a common occurrence among the Brachiopoda; it may be especially observed in the flat species of Orthis, and in many Leptænæ, covering all the central parts of the shell, and leaving the punctuations open only round the margin. Among the Productæ and some species of Chonetes, the punctuations are closed up everywhere, except at the edge, by a gradual deposit of shelly matter in the interior. In *Crania*, *Thecidea*, and some recent *Terebratulæ*, the punctuations can only be seen in the interior round the edge of the shell; but in the majority of the recent species of Terebratula, they are equally visible over the whole shell." This statement will be perfectly correct, if

distance from this. From the indistinctness of the *breaks* between the older and the newer portions of the shell, both here and elsewhere, I am inclined to think that the formative action must be more constant and gradual among the Brachiopoda, than it seems to be among the Mollusca generally.

Excluding the *Discinidæ* and *Lingulidæ*, whose shells are almost entirely composed of a horny animal substance, the shells of Brachiopoda may be said to be almost exclusively calcareous in their composition; the proportion of animal matter which they contain, being far less than that which exists in the shells of most Lamellibranchiate bivalves. When a portion of the shell of a recent Terebratula which has been preserved in spirit, is submitted to the action of dilute acid, the greater part of it is speedily dissolved with effervescence; and in the membranous residue I have not been able to distinguish with certainty and uniformity more than two layers, both of great tenuity, but one of them considerably thicker than the other. This thicker layer, which is usually of a yellowish hue, obviously covers the exterior in the manner of the *periostracum* of most Lamellibranchiate shells, although more closely incorporated with its substance; whilst the thinner layer, which is quite pellucid and colourless, appears to have lined its interior, this also being so closely incorporated with the shelly texture, as not to be separable from it without the complete destruction of the latter. I have not been able to discern any distinct *structure* in either of these membranes, although they exhibit faint markings, which I am disposed to regard as nothing else than the impressions left upon them by the peculiar shelly texture with which they are in contact. Intermediate layers are occasionally to be met with, sometimes resembling the inner membrane, and sometimes the outer, in their characters. A repetition of the inner membranous layer may of course be expected wherever a new layer of shell is formed within the old; and I have found that such a layer is sometimes furnished, in Crania, though not in Terebratula, with its own periostracum.

It is, however, in the texture of the substance which intervenes between these layers of membrane, that the most characteristic peculiarity of the shells of the Brachiopoda exists. In all the recent *Terebratulidæ* and *Rhynconellidæ*, and in all the fossil specimens of those groups, as well as of *Spiriferidæ*, *Strophomenidæ*, and *Productidæ*, in which there is no indication of metamorphic action, the shell is found to consist of flattened prisms, of considerable length, arranged parallel to each other with great regularity, and at a very

we substitute for the term "a layer of unpunctuated shell," "a layer of shell having *minute punctuations*." When the uses of these passages (which are very different from what Mr. Sharpe supposed them to be) come under discussion (p. 29), it will be seen to be very improbable that they should in any instance be closed-up from the *inside*. No such statement can be justified, save by a careful microscopical examination of a *transparent* section of the substance to which it relates, especially in *fossil* specimens, in which, from the channels in the shell being filled with the matrix, their orifices (the punctuations) are often almost indistinguishable, even when of considerable size (see p. 31). And all my own observations— ome of them made upon specimens kindly supplied to me by Mr. Sharpe—lead me to believe that the passages always retain their internal openings (as seen in Pl. V, fig. 8), although these may be of very minute size.

acute angle—usually only about 10° or 12°—with the surfaces of the shell. These prisms range from about 1-2000th to 1-600th of an inch in breadth, the average being probably about 1-1000th of an inch, and are not above one tenth of the last-named amount in thickness. With regard to their length, I am not able to speak positively, as I have never succeeded in tracing any single prism continuously from one of its extremities to the other; but I have frequently met with prisms, broken at one end, whose length measured 1-50th of an inch. It sometimes happens that a shell of a recent *Terebratula*, which has been kept for some time in spirit, can be readily resolved into such prisms, even by rubbing portions of it between the fingers (Pl. I, fig. 5); but more commonly they are best made apparent, by cleaving the shell in the plane in which they lie. Most Brachiopodous shells readily admit of this kind of cleavage; but it is more easily practised with the *Rhynconellidæ*, *Spiriferidæ*, and *Strophomenidæ*, than it is with the Terebratulidæ. When their natural laminæ thus obtained are examined microscopically, the flattened prisms are seen to lie side by side with great regularity (Pl. IV, fig. 6; Pl. V, figs. 4, 6), usually overlapping one another at their edges; they are sometimes gently curved *laterally*,[1] but they never seem to depart widely from the straight line in that direction. The laminæ which they thus form, however, are often far from being flat; and this, which is particularly the case in those parts of the shell whose curvature is great, is due to the inflexion of the prisms in the direction of the *thickness* of the shell; so that, when seen in a vertical section, they often present considerable curvatures, especially towards their extremities, when these abut upon the perforations for the vascular canals (Pl. IV, fig. 4; Pl. V, fig. 14). The *internal surface* of the shell derives a most peculiar appearance from the 'cropping-out' of these prisms at the acute angle just mentioned; for it presents a very regular imbricated aspect (Pl. IV, figs. 7, 10, 11, 14; Pl. V, figs. 4, 5), each of the imbrications being the rounded extremity of one of the flattened prisms. The *external surface*, owing probably to the incorporation of the periostracum with the terminations of the prisms, does not distinctly show any such arrangement; but, when a little abraded, as happens in most fossil specimens, it very commonly exhibits the ends of the prisms cropping-out upon the surface at an extremely slight inclination, but without any regularly-formed terminations. When a *section* of the shell is made more or less parallel to its surface, this may traverse the prisms for a time in their own plane, or nearly so, and they will then present almost the same appearance as they do in a natural lamina; but it may cross the prisms more or less obliquely (Pl. V, fig. 3), and the appearances presented will vary according to the degree of that obliquity. Not unfrequently, owing to the curvature which has been already noticed as presented by the prisms, a section will traverse them in one part almost in the plane of their length, and will cross them very obliquely at another. A great variety of appearances may thus be presented by the shells of

[1] That is, when considered in relation to the shell of which they form part, their general line of direction being from the umbo towards the margin.

Brachiopoda, which are at once understood when the form and arrangement of their component prisms have been duly studied.[1]

The question now arises,—what is the *histological* character of these prisms, and in what way are they formed? Considering that they bear a certain degree of resemblance, both in form and arrangement, to the component prisms of the shells of Pinna, &c. (their chief differences being that they are flattened, instead of being hexagonal or nearly so, and that they lie at a small inclination to the surfaces of the shell, instead of passing vertically from one surface to the other), it might be not unfairly surmised that they are formed, like these, as *elongated cells*. It seems at first sight an objection to this view, and was long felt as such by myself, that no trace of cellular membrane is discoverable after the action of acid upon the prismatic substance; but this is true of a great many other shells also, in which, as I think I have shown to be almost certain, if I have not absolutely demonstrated,[2] the shelly texture was originally of a truly cellular nature. Now, it is a very curious circumstance, that in the shell of *Crania*, the greater part of which presents none of the characteristic Brachiopodous structure, there should be one portion,—that to which the muscles (or rather their tendons) are attached,—which is distinctly prismatic, the prisms having very much the appearance of those of *Terebratulæ*, but being arranged vertically to the surface of the shell as in *Pinna* (Pl. V, fig. 8, *a*, *b*): and that in this structure, a series of elongated cells may be distinctly traced, standing parallel to each other, and presenting their prismatic extremities on the inner surface of the shell (Pl. V, fig. 8); these retaining their structure and arrangement in the decalcified shell (Pl. V, fig. 13). And thus the presumption becomes greatly strengthened, that the component prisms of Terebratulæ, Rhynconellæ, &c. were originally formed within a cell-membrane, and have taken the shape of the cell-cavity within which they were moulded. Further, the component prisms of the shell of *Rhynconella octoplicata* exhibit a remarkable double-oblique striation (Pl. V, fig. 6), which somewhat resembles the transverse striation seen on the prisms of Pinna, and which suggests the idea that each of its long prisms is formed by the coalescence of a series of flattened cells linearly arranged, as I have shown to be the case with those of Pinna.[3]

In a large proportion of the species of *Brachiopoda*, the shell is traversed by a system of canals, which pass from one surface to the other, for the most part in a nearly vertical direction, and at tolerably regular intervals. The diameters of these canals differ greatly in the several species which exhibit them, as do also their distances from each other, and, consequently, the number which present themselves within a given area; as will be seen by comparing together figs. 6, 7, 8, 11, 12, 14 of Plate IV, and figs. 1, 2, 3 of Plate V,—

[1] The peculiar structure of the shells of Brachiopoda is liable to be much obscured by mounting the sections in Canada balsam, which goes far to obliterate the lines of division between the prisms. It is on this account alone, that the sections delineated in figs. 1 and 2 of Pl. V do not exhibit the same appearance as fig. 3.

[2] See my Memoir on Shell-Structure, in the 'Report of the British Association for 1847,' p. 98.

[3] Op. cit., 1844, p. 8, and 1847, p. 96.

all of which are drawn under the same magnifying power, namely 100 diameters. Among the recent Terebratulæ, there is none which have canals of larger size or more closely set than *Waldheimia australis* (Pl. IV, figs. 6, 7, 8), their average diameter being about $\frac{1}{800}$th of an inch, and the distance of their centres about $\frac{1}{400}$th. It is in *Terebratulina caput-serpentis* (Pl. IV, figs. 11, 12), on the other hand, that the canals are of smallest dimensions, their largest diameter being about $\frac{1}{1500}$th of an inch, whilst their average distance from each other is about the same as in the preceding case,—their regular arrangement, however, being so modified, that the external orifices are principally seen upon the elevated parts of the plications (fig. 12), whilst they open internally in similar rows (fig. 11). Among the fossil species of Terebratulæ, *Ter. bullata* (Pl. V, fig. 1) is among the most remarkable for the size of its canals, their diameter being about $\frac{1}{400}$th of an inch; whilst in *Ter. lima* (Pl. V, fig. 2), whose shell-canals are smaller than those of any Terebratula, recent or fossil, that I have examined, their diameter is scarcely $\frac{1}{2000}$th of an inch. The relative distances of the centres of the canals, however, are nearly the same in these two species, averaging about $\frac{1}{250}$th of an inch, so that about the same number may be counted in any given area; thus showing that there is no fixed relation in the development of the canal-system, between their *size* and their *number*. The largest canals which I have met with in any Brachiopod shell, are those of *Spiriferina rostrata* (Pl. V, fig. 3), these being about $\frac{1}{300}$th of an inch in diameter. Their number in a given area, however, is much less than it is in the Terebratulidæ generally, the distances of their centres averaging about $\frac{1}{160}$th of an inch; so that the proportion which their united areæ bear to that of the shell is not very different from that which obtains in *Terebratula australis*, or *Ter. bullata*,—the diameter of each canal being, in these species, from about one-half to five-eighths of the distance between the centres of the contiguous canals.

In all these statements, however, the *largest* diameter of the canals has been alone considered; and this, in the *Terebratulidæ*, is usually near the *exterior* of the shell, the canals expanding as they approach this, so as usually to present somewhat of a trumpet-form (Pl. IV, figs. 3, 4). Hence, the diameter of the internal orifices of the canals is frequently not more than one-half, sometimes not more than one-third, of that of the exterior; and it is still further reduced, when a new layer of shell has been formed within the preceding (as already noticed, p. 24). Of this, a good illustration is shown in Pl. IV, fig. 3, where *d d* marks the plane of junction between the new layer and the old (its position in the shell being seen at *d d*, fig. 1), below which the canals are seen to be contracted to about one-half the diameter of their ordinary internal terminations. Sometimes the canals are seen to bifurcate in their passage from the interior towards the exterior of the shell (Pl. IV, fig. 4); this bifurcation, however, is not common in Terebratulidæ. The external termination of each canal is covered with a sort of discoidal operculum (Pl. IV, fig. 8), which is much thicker and more opaque than the periostracal membrane; to this it usually remains adherent when the calcareous shell has been dissolved away by dilute acid, but it is occasionally found to be detached from it, so that the adhesion can scarcely be

complete. In many Terebratulæ, these disks are seen to be surrounded by delicate radiating lines, as was first pointed out by Mr. Quekett;[1] the nature of these is somewhat obscure, but from the appearances presented by certain preparations made from young shells by Mr. Quekett, I am disposed (with him) to consider them as *cilia*, whose office it is to produce currents of water over the extremities of the cæca, for the purpose of aerating their contents.

The case is very different, however, with the *Craniadæ;* for here the canals, instead of enlarging as they approach the exterior, subdivide in an arborescent manner (Plate V, fig. 8); and thus, instead of presenting on the external surface a set of definite discoidal terminations, their ultimate ramifications alone are seen (Pl. V, fig. 12). The largest diameter of the canals is here at their *internal* orifices, save where these are contracted by the interposition of a new internal layer (as already noticed, p. 24), between the preceding and the surface of the mantle, in the manner shown in fig. 8.

When it was first discovered that the "punctuations" which had been previously noticed upon the surface of many Brachiopodous shells, are really the orifices of canals penetrating the whole thickness of the shell,[2] it was natural to inquire what is their probable function in the economy of the animal; and at the time when it was not known that they are closed externally by a discoidal operculum, the opinion seemed not an improbable one, that they are in some way connected with the function of respiration, serving to introduce water into contact with the surface of the mantle which lines the shell. Subsequent research,[3] however, showed that they are occupied in the living animal by cæcal tubuli, which extend into the shell from the membranous layer that is incorporated with its inner surface. These are best seen by exposing a portion of a shell that has been preserved in spirits, with the animal, to the action of dilute acid; for attached to the membranous films that form the residuum, are then found a multitude of cæca, more or less crowded with yellowish-brown cells (Plate IV, fig. 9), and corresponding in size and arrangement with the passages in the shell. If the process of decalcification be stopped at a fitting time, a lamina of shell may be preserved, with the tubular cæca corresponding to its whole previous thickness projecting from its surface (Pl. IV, fig. 13); thus conclusively proving that their true place is actually in the midst of the shell-substance. Similar cæca, less crowded with cells, may be readily detected in the membranous residuum of a recent *Crania* (Plate V, fig 11).

It is of considerable importance to the due estimation of the zoological value of the character afforded by the presence or absence of the perforations, that the physiological nature of these cæca should be clearly determined. I regret that I have not yet been able

[1] Histological Catalogue of the Museum of the Royal College of Surgeons, vol. i, p. 270.

[2] This discovery was first announced in the author's Paper on the Microscopic Structure of Shell, read at the Royal Society, Jan. 17, 1843, of which an abstract was published in the 'Ann. of Nat. Hist.,' Dec., 1843.

[3] See the author's Memoir in the 'Reports of the British Association for 1847,' p. 93.

to succeed in obtaining a clear elucidation of this point; still, I cannot but think that a near approximation may be made to it. I have already mentioned, that with the internal surface of the shell is incorporated a membrane, of which the cæcal tubuli are prolongations; and I have found the free surface of this membrane to be almost covered with cells, resembling both in size and appearance those contained in the cæca. I have found similar cells upon that surface of the mantle which is applied to the interior of the shell, and which (as long since remarked by Professor Owen) possesses a degree of adhesion to it, that does not exist among the Lamellibranchiata. Hence I am much inclined to believe that, as was first suggested to me by Mr. T. H. Huxley, the space between the mantle and the proper lining membrane of the shell is, in reality, a great vascular sinus; and that the membranous cæca opening-off from that space are really to be considered as vascular processes, analogous to those which present themselves in the "test" of many Ascidians.[1] The cells which are contained in these cæca, and which are found so abundantly on the contiguous surfaces of the mantle and the interior shell-membrane, must then be considered as blood-corpuscles.

It can scarcely be supposed that these vascular prolongations can have any relation to the nutrition of the shell; since we find them absent in a considerable number of the shells of Brachiopoda, which in every other respect are formed upon the same type with those wherein these cæca abound. We can scarcely do otherwise, I think, than regard their presence or absence as bearing a relation to the general economy of the animal; and they must consequently be admitted as furnishing a character of considerable importance in a systematic point of view. We shall find, accordingly, that (so far as yet known) they exist in all the true *Terebratulidæ*, both recent and fossil; and that (with the same reservation) they are absolutely and entirely wanting in all the true *Rhynconellidæ*, both recent and fossil; so that by this character alone, any member of the former family might be safely diagnosed from any member of the latter.

As frequently happens, however, in other departments of Zoology, a character which

[1] The peculiar appearance of these cæca and their contained cells, led me at one time to surmise that they might possibly be the extremities of the ramified ovaria, which extend themselves through the mantle; or that, like the glandular clusters in the dorsal papillæ of the Eolidæ, they might constitute a subdivided liver. Neither of these views, however is consistent with the entire disconnection of the cæca with the proper mantle, and the animal it encloses; and, moreover, as Professor Owen has remarked to me, "these palleal processes are so much more minute than the ova discernible in the ramified ovaria, and their presence is so equally manifested on the ovarian and non-ovarian parts of the mantle, that no ground is to be got for associating them in speciality of function with the generative system; whilst the palleal lobes are so thoroughly distinct (in comparison with the skin of Nudibranchs) from the visceral mass, that they cannot have any special relation to the liver." I mention these surmises and their refutation, merely to assist in determining, *par voie d'exclusion*, what is the real character of these palleal processes; it being often easier in physiology to determine what a thing or function *is not*, than what it *is*. Professor Owen permits me to state, that he considers the view given in the text to be not discordant with the results of his researches on the vascular system of the Terebratulidæ.

is of typical value as affording an absolute distinction between certain families, possesses a greatly inferior value as regards others; thus we shall find that both *Spiriferidæ* and *Strophomenidæ* contain perforated and non-perforated shells; and it will be for further investigation to determine, whether the character has here a *generic* value (serving, for example, to distinguish Spiriferina from Spirifer, Orthesina from Orthis), or whether it must here rank as a mere specific difference. The details which I shall presently furnish, may help towards the determination of this point; but it will require a far more complete and extended investigation than I have had either time or opportunity for making, to determine the real import of this character in every group in which it seems to be otherwise than constant.

Such an investigation, however, to be of any value, must be made with great care; *superficial* observations being here worse than useless, because they are liable to give the most erroneous results. The perforations in the shells of fossil Brachiopoda are very liable to be filled-up by the matrix; and such a smoothness and apparent continuity may thus be given to their surfaces, that no "punctuations" may be perceptible by the microscopist, still less by the observer who is armed only with a hand-magnifier. On the other hand, the surface of some shells is marked in such a manner, as to indicate the presence of the perforations with almost absolute certainty to any one who has not learned caution from previous experience; yet the infallible test of a transparent section, examined under a sufficient magnifying power, makes it evident that there is not the slightest vestige of real perforations, and that the supposed "punctuations" are nothing else than surface-markings, analogous to the "sculpture" of other shells. Of the importance of such precautions, a very remarkable example is afforded by the existence of perforations in *Strigocephalus*, which has been uniformly regarded as a non-punctuated shell, and placed among the Rhynconellidæ, whilst its real position (as the presence of perforations would indicate) has been found by Mr. Davidson to be among the Terebratulidæ. Conversely, the perforations are really wanting in *Porambonites reticulata*, notwithstanding that there is a most decided and regular "pitting" of the surface of the shell, extremely resembling the large punctuations of some of the Terebratulidæ and Spiriferidæ; the place assigned to this genus on other characters being among the Rhynconellidæ, the existence of perforations in its shell would have been anomalous.[1]

[1] I lay the more stress on the importance of this method of examination, because an attempt has been made by Professor King (Monograph of the Permian Fossils of England) to put aside my former observations, made with *adequate microscopic power* upon *transparent sections* of the shells, as altogether valueless, on the strength of an examination of their *surfaces* with a *Stanhope-lens*. "Dr. Carpenter," he says (p. 110, note), "places Hypothyrises (Rhynconellæ) in his non-perforated division of the Brachiopods; but punctures, although much more minute than those in the Terebratulidæ, occur in every species that has passed under my notice. Punctures also occur in *Productidæ* and *Spiriferidæ*; in short, *I doubt their absence in any Brachiopod whatever.*"—Now I have Professor King's own authority for stating, that he has relied *entirely* on superficial observations made with a hand-magnifier, than which, as I have shown above, nothing can be more fallacious; and further, that he has never himself examined the

The foregoing statements will be found to apply, more or less fully, to all the families into which the Brachiopoda are subdivided by Mr. Davidson, except the *Discinidæ* and *Lingulidæ*, in whose shells a different type of structure prevails, which will be described in the special account of those families.

Family—TEREBRATULIDÆ.

The shells of all the genera included by Mr. Davidson in this family, exhibit the structure previously described, in its most characteristic form; and all of them are perforated by the system of passages which give place to the cæcal prolongations of the lining membrane. It is interesting to remark, that these passages do not exist in the calcareous 'loop,' whose structure is in other respects precisely the same as that of the shell. (Pl. IV, fig. 2, *a a*, and fig. 10.) The following is the list of species, recent and fossil, which I have examined; the former including all those contained in the unrivalled collection of Mr. Cuming, to which that gentleman has kindly allowed me free access for that purpose. Of the recent species marked *, I have been enabled to make transparent sections, chiefly by the liberality of Mr. Cuming in furnishing me with specimens for that purpose; the remainder have been determined by the examination of the surface alone; but the source of fallacy which has been already shown to render this method insufficient as regards the *fossil* Brachiopoda, does not exist with respect to the *recent*, since it is impossible for any practised observer to confound, in the latter, *superficial depressions* with *actual perforations*. Of *all* the *fossil* species enumerated under this and other heads, I have made *transparent sections;* deeming it unsafe to speak in regard to them from superficial examination alone.

Terebratula.—Recent, *T. dilatata, globosa, uva, vitrea;*—Fossil, *T. Bentleyi, biplicata, bullata,*[1] *carnea, coarctata, fimbria, globata, grandis, intermedia, maxillata, perovalis, punctata, sacculus, Salteri?* (see Retzia, p. 34), *sphæroidalis, squamosa.*

Waldheimia.—Recent, *W. australis* *,[2] *californiana, cranium, flavescens, Grayii, lenticularis, picta;*—Fossil, *cornuta, digona, impressa, numismalis, oblonga, obovata, ornithocephala, resupinata.*

recent *Rhynconella psittacea*, of whose structure I had given illustrations, in the Memoir with which Professor King must have been acquainted (Reports of British Association for 1844), sufficiently ample, it might have been thought, to make him pause before committing himself to such a sweeping assertion. To myself, personally, it is a matter of entire indifference, whether Professor King does, or does not, admit the correctness of my observations; but I would submit that the interests of science are not very likely to be promoted, by this easy setting-aside of observations, made with every advantage of first-rate instruments and careful preparation of specimens, in favour of glances with a hand-magnifier at shells whose surfaces are peculiarly liable to present deceptive appearances, the examination being confined to their exterior, and no adequate means being taken to examine their intimate structure and arrangement. When Professor King shall have demonstrated the existence of a system of shell-canals in *Rhynconella psittacea*, it may be reasonably permitted him, "to doubt the absence of perforations in any Brachiopod whatever."

[1] Pl. V, fig. 1.

[2] Pl. IV, figs. 1—10.

Many of these might probably be distinguished from each other by the size and arrangement of the shell-canals; but until it shall have been determined, by the examination of numerous specimens, what are the limits of variation in this respect, it would be unsafe to employ this character for the diagnosis of species, except where a very strongly-marked difference presents itself. One of the most remarkable departures from the usual regularity of their arrangement, is presented by *Ter. coarctata*, the surface of whose shell is covered with square or oblong elevations, arranged in rows, and occasionally running together into ridges; for the canals usually pass towards the highest parts of these elevations, so that their orifices are there crowded together, whilst in the intermediate furrows there are scarcely any to be seen.

Terebratulina,—Recent, *abyssicola, angusta, cancellata, candida, caput-serpentis* *,[1] *Cumingii, japonica, septentrionalis.*

Terebratella,—Recent, *Bouchardii, chilensis, coreanica, Cumingii, dorsata, Evansii, flexuosa, inconspicua, labradorensis, rubella, rubicunda* *, *sanguinea, spitzbergensis, zelandica*;—Fossil, *hæmispherica?*

Magas,—Fossil, *pumilus.*

Bouchardia,—Recent, *tulipa* *, Blainv. = (*rosea*, Humph.)

Kraussia,—Recent, *cognata, Deshaysii, Lamarckiana, pisum, rubra* *.

Megerlia,—Recent, *pulchella* *, *truncata* *;[2] Fossil, *lima.*[3]

The greater part of the internal surface of the shell *Megerlia truncata* is studded with little papillary eminences, on which the shell-canals do not open. (Plate IV, fig. 14.[2])

Morrisia,—Recent, *anomioides* = (*depressa*, Forbes.)

Argiope, — Recent, *cistellula, cuneata, decollata, lunifera, neapolitana*;—Fossil, *decemcostata.*

Strigocephalus,—Fossil, *Burtini.* (See p. 31.)

Genus—Thecidea.

In this genus—which, if associated with the *Terebratulidæ* at all, must be considered as a very aberrant form of that family—the structure of the shell is much less characteristic than it is in the *Brachiopoda* generally, and much less distinguishable from that of ordinary bivalves. From appearances which I have occasionally detected, I am inclined to believe that the shell is originally formed on the same plan with that of other *Brachiopoda*, but that the component prisms subsequently coalesce, so as to form a more compact texture. The shell-canals are very obvious in the recent *Thecidea mediterranea* *, opening

[1] Pl. IV, figs. 11—13.

[2] By a mistake on the part of the artist, these eminences are not made to exhibit the imbricated arrangement of the extremities of the prisms, which they present in common with the remainder of the internal surface of the shell.

[3] Pl. V, fig. 2.

upon its external surface in rows along the ridges (Plate V, fig. 10). They are also very evident in the fossil *Th. leptænoides;* but I am not by any means sure of their presence in *Th.mayalis, Moorei, sinuata,* and *triangularis.* In the specimens of these which I have examined, however, the shell was so far from being well preserved, that I do not feel inclined to speak confidently upon the point.

Family—SPIRIFERIDÆ.

In all the genera of this family, the structure of the shell is completely conformable to the general description already given; but the system of shell-canals no longer exhibits the same constancy, being, in fact, more generally *absent* than present.

Spirifer.—In this genus, as usually constituted, there is a great diversity in regard to the presence or absence of the perforations; but Mr. Davidson has been led, by considerations altogether independent of them, to divide it in such a manner that the perforated and non-perforated species fall into distinct sections. Thus, he makes his genus *Spirifer*-proper to consist of those species which, like *Sp. striatus,* are unpunctuated, and without a mesial septum in the larger or ventral valve. Under this head rank *Sp. comprimatus, concentricus, speciosus,* and *Verneuilli,* which I can state with confidence to be non-perforated (notwithstanding Professor King's assertion to the contrary), not the least trace of passages being discernible in sections which display the texture of the shell in the greatest perfection. Under the sub-genus *Cyrthia,* he places these unpunctuated species, which, like *C. trapezoidalis,* have a perforation for the passage of a pedicle; besides this species, I have examined *C. cuspidata,* and am fully satisfied that in neither of these do any perforations exist. Under the sub-genus *Spiriferina,* on the other hand, he ranks all the species which, like *Sp. rostrata,* are punctuated, and which have a largely-developed mesial septum in the ventral valve. I have determined the existence of perforations in *Sp. Demarlii, heteroclyta, rostrata,*[1] *and Walcotii.*

Athyris.—In this genus, also, it is proposed by Mr. Davidson to separate the perforated and non-perforated species, which fall into different sub-generic sections respectively, according to other features in their structure. The typical species of the genus, such as *A. herculea* and *A. tumida,* I have ascertained to be non-perforated. The same is the case with *concentrica,* which Mr. Davidson now ranks under the sectional type *Spirigera,* with other unpunctuated species. On the other hand, the punctuated species, such as *esquerra* and *melonica,* in which I have found the perforations to exist, are placed by him under the sectional type *Retzia;* and he thinks it probable that *Ter. Salteri* will have to be transferred to this sub-genus.

Uncites.—Of this genus, I have examined only *U. gryphus,* which is not perforated.

Atrypa.—In none of the species of this genus which I have examined, namely *A. affinis, marginalis,* and *reticularis,* is there the least trace of perforations.

[1] Pl. V, fig. 3.

Family—RHYNCONELLIDÆ.

In the shells of this family, I believe the *absence* of the perforations to be a character as constant, as their presence is in the *Terebratulidæ*. No one who examines the shells of the recent *Rhynconella psittacea* and *Rh. nigricans*, even in the most superficial manner, can have any hesitation in recognizing the entire absence of the superficial "punctuations" which mark the orifices of the shell-canals in the recent species of *Terebratulidæ*;[1] and the most careful microscopic examination of these sections of the shell, taken from any part, and in any direction, does but confirm this conclusion. Thus, in Plate V, fig. 4, is shown a considerable area of the interior of the shell (*a*, *a*), which displays the usual imbricated arrangement of the extremities of its component prisms, shown on a larger scale in fig. 5; whilst these prisms are exhibited in their longitudinal aspect by a fracture of the shell at *b*, *b*. In neither part can the least trace of perforations be seen.[2] In all other respects, the intimate structure of the shell corresponds precisely with that of *Terebratulidæ*; but it may be mentioned that the prismatic laminæ are less adherent to each other than in the perforated shells, so that they are readily split asunder, this being the case with the fossil no less than with the recent species.

Rhynconella.—Recent, *psittacea* *,[3] *nigricans* *;—Fossil, *acuta, concinna, decorata, depressa, inconstans, lata, nucella, obsoleta, octoplicata*,[4] *plicatella, pygmea, rostrata, spinosa, subplicata, tetraedra*.—The only peculiarity which I have met with among these, is a peculiar oblique striation of the prisms of *Rh. octoplicata*, already described (p. 27).

Camerophoria *Schlothemii*, not perforated.

Pentamerus *Knightii*, not perforated.

Porambonites.—It is not a little remarkable that in this genus the shell should be most unequivocally *non-perforated*, notwithstanding that the punctuation of the surface, in one species especially, has led to the supposition that large "pores" exist, whence, I presume, the generic name has been derived. The most careful microscopic examination of transparent sections, fails to bring into view any perforations either in *P. æquirostris* or in *P. reticulata*.

[1] In Mr. G. B. Sowerby's 'Monograph of the Genus *Terebratula*,' in which these two species are described under that generic designation, they are spoken of as "the only species that are not punctuated."

[2] I cannot refrain from here again expressing my astonishment, that any systematist should venture to affirm the universal existence of perforations in the shells of Brachiopoda, without having examined one of the most common of the recent types of the group, in which the absence of such perforations had been specified as a distinctive character by competent observers.

[3] Pl. V, figs. 4, 5.

[4] Pl. V, fig. 6.

Family.—STROPHOMENIDÆ.

In this family, as in *Spiriferidæ*, there is a want of constancy as regards the shell-canals; and further investigation is much needed to determine how far the character which is furnished by their presence or absence corresponds with those other characters on which generic distinctions may be most securely based.—The results of the examinations which I have hitherto made are as follows:—

Orthis.—The prevalent character in this genus is that of perforation, which presents itself in the following species: *biloba*, *canalis*, *elegantula*, *filiaria*, *hybrida*, *Michelini*, *resupinata*, *striatula*, *testudinaria*. Of nearly all these it is particularly noticeable that the openings of the perforations on the external surface of the shell are arranged in regular rows on the ridges of the plications. The only species in which I have not found the perforations to exist, are *O. biforata* and *calligramma*.

Orthesina.—So far as I at present know, the shells of this genus are *not* perforated. The species which I have examined are *O. ascendens*, *elegans* [?], and *hemipronites*.

Strophomena.—Here, on the other hand, the perforation of the shells seems to be the rule; but the perforations are unusually remote from each other (Pl. V, fig. 15 *a*), and the laminæ of the shell are bent down round the margin of each, so as to give it a somewhat infundibular character in vertical or oblique sections (fig. 14 *b b*, fig. 15 *b b*). The shells of this genus which have fallen under my examination, have for the most part undergone so complete a metamorphosis, that their original texture is almost entirely obscured; and even the perforations, when filled-up by a matrix of nearly the same appearance with the metamorphic shell, may pass undetected, save when carefully looked for: I have found their existence to be sometimes more certainly revealed by *vertical* than it is by *horizontal* sections. The species which I have examined are *alternata*, *depressa*, *funiculata*, and *planoconvexa*; in all of which the perforations are clearly distinguishable.

Leptæna.—In one of the most characteristic species of this genus, *L. transversalis*, the shell is obviously traversed by perforations, resembling those of *Strophomena depressa* in their size, distribution, and arrangement. I have found similar perforations in *L. semiovalis*. On the other hand, I have examined specimens of *L. Davidsoni* and *L. oblonga* without being able to recognise them; in these specimens, however, the shell had undergone such a complete metamorphic action, that it would be very unsafe to affirm the non-existence of perforations in these two species.

Family.—PRODUCTIDÆ.

In all the genera of this family large perforations exist, resembling those of *Strophomena depressa* in their general aspect, and in the infundibular arrangement of the

laminæ of the shell around them. Where the shell is furnished with spines, as is especially the case with *Productus horridus,* the perforations are continued into them; and such passages are of more than the average dimensions. The shells of this group have for the most part undergone such a metamorphic action, that I cannot speak confidently with regard to the conformity of their texture to that of the Brachiopoda generally; but for the reasons already given (p. 24), I have no reason to believe it to have been different. I am disposed to think, however, that in some of the massive shells of this group, which appear to have been formed by the addition of successive laminæ to the interior, the internal laminæ were sometimes destitute of perforations—at least at a distance from the margin—as stated by Mr. D. Sharpe. Still, unless this point can be satisfactorily made out in shells whose original texture have been well preserved (if such should fortunately present themselves), it would be unsafe to make a positive affirmation regarding it.

Productus.—Of this genus I have examined the following species;—*Cora, Flemingii, horridus,* and *striatus,* all of which have well-marked perforations.

Strophalosia.—The two species of this genus which I have examined, viz., *Sedgwickii* and *sub-aculeata,* are both perforated like Productus.

Chonetes.—Of this genus, also, I have examined two species, *armata* and *lata,* both of which are perforated.

Genus—Calceola.

Though I have examined several specimens of *Calceola Sandalina,* I have not met with one in which the texture was sufficiently well preserved to enable me to speak positively as to its character. I have no reason, however, to regard it as having departed from the ordinary type; and I have not been able to detect any distinct traces of perforations.

Genus—Crania.

The structure of the shell in this genus, as determined by the examination of the recent *Crania norvegica,* is widely different from that of Brachiopoda generally. Instead of a series of flattened prisms arranged with great uniformity, we only meet with a substance which does not present any regularity or distinctness in the arrangement of its components, but which is not at all unlike that of which many Lamellibranchiate shells are composed, and may probably, like it, be regarded as having been originally formed by the coalescence of cells, which were destitute of any constancy in size, shape, or general arrangement. But whilst departing from the general Brachiopodous type in this respect, the shell of *Crania* is quite conformable to it, in being penetrated by canals which are prolonged from the lining membrane of the shell, and which pass towards its

external surface. These differ from those of Terebratulæ, however, in not arriving at that surface, and in breaking-up into minute subdivisions as they approach it (Plate V, figs. 8, 12). They usually open near the internal margin of the valves, by orifices so large as to be apparent to the naked eye (fig. 7); but nearer the central part of the valves, their orifices are frequently so minute as not to be readily discernible. This is in consequence of the formation of an additional lamina within the old one, and of the contraction of the canals in their passage through it, as is seen in the lower part of the vertical section shown in Plate V, fig. 8. The texture of the shell, at the part where the muscles are attached to it, is distinctly prismatic, the prisms being arranged vertically, so that their polygonal extremities alone present themselves at this part of the internal surface, (Plate V, fig. 9), the openings *a*, *a*, *a*, of the shell-canals being seen even here. It is curious to observe that this prismatic substance presents itself in the external and older layers of the shell, in nearly the same situation as in the most internal or newest, (as shown at *a*, *b*, Plate V, fig. 8); although several intervening laminæ may have been formed, some of them separated from the rest by a renewal of the periostracum, and the shell extended by them as well as thickened. When a portion of the shell of Crania has been decalcified by dilute acid, a membranous residuum is obtained, having the cæcal prolongations in connection with it (Plate V, fig. 11); these closely resemble the cæca of Terebratulæ, but are less filled-up with cells. The prismatic substance to which the muscles are attached, yields a definite animal basis of a cellular character (Plate V, fig. 13), closely resembling that of the *Margaritaceous* family, but more delicate and of smaller dimensions, the average diameters of the prisms being not above 1-1800th of an inch.

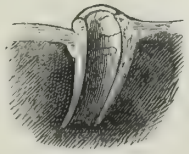
The fossil specimens of Crania which I have examined, namely, *C. antiqua* from the chalk, and *C. antiquior* from the Great Oolite, present the same characters, so far as the state of preservation of the shell allows them to be discerned. It may be remarked that from the filling-up of the perforations with a matrix harder than the shell, and from the abrasion of the latter, the large orifices of the perforations upon the inner margin of the shell are frequently marked by papillary elevations, instead of by depressions. This appearance is not unfrequently presented on the surface of fossil Terebratulæ.

Genus Siphonotreta.

This genus is remarkable for the penetration of its shell (of the intimate texture of which I cannot speak, on account of the metamorphic condition of the species which I have examined) by canals which have the same general arrangement with those of Productidæ, and which, as in that family, pass up into the spinous or verrucose outgrowths from the shell.[1] In a vertical section which I have made of the very thin shell of

[1] See Dr. S. Kutorga's Memoir 'Ueber die Siphonotreteæ,' &c.; St. Petersburg, 1848.

verrucosa, these passages appear to be prolonged *inwards*, by infundibular extensions of the shell, which project for some distance into its cavity, as shown in the annexed woodcut.



Family.—DISCINIDÆ and LINGULIDÆ

The structural character of the shell, in these two families, is altogether peculiar. For in the first place it is composed of a great number of very thin laminæ, arranged parallel to the surface; to which plan of structure we have seen that an approach is presented in Crania. Next, the substance of these shells (in the recent species at least) is horny, instead of being calcareous, thus resembling the periostracum of other shells; and further, it is penetrated by minute tubuli of extreme minuteness, resembling those of dentine, instead of by large perforations. These tubuli run parallel to each other (Plate V, fig. 16, *a a*), usually in an oblique direction, though near the margin of the shell they may often be seen to be parallel to the surface. In *Discina* they are commonly arranged in fasciculi, so that their transverse section presents a series of clustered dots, as seen at *b b*, sometimes, however, presenting the arrangement seen at *c*; both of these plans suggest the idea of a cellular structure as the original basis, but of this I have not been able to obtain any satisfactory evidence.

Attention has been drawn by Mr. Daniel Sharpe to an apparent departure of a very remarkable kind from the usual plan of structure, in the genus *Trematis*,[1] the shell of which he describes as composed of two layers, the external one being regularly punctuated, like that of the *Terebratulidæ*, whilst the internal is destitute of all trace of punctuations. This he endeavours to show to be only an extension of a plan of structure common among other *Brachiopoda*, namely, that the internal layer is frequently imperforate towards the centre of the valve. On this general statement I have already had occasion to remark (p. 24, note); and have now to show that it is altogether inapplicable to the case before us. For I have ascertained, by careful examination of the shell of *Trematis*, that it is formed on the general plan of the shells of the *Discinidæ*; and that it has not in reality the slightest relation to the Terebratulidan type. The external markings are of the most superficial character possible, and no more indicate *perforations*, than do those of *Porambonites*. They are confined to the outermost of the *numerous* thin laminæ of which the shell is composed; and although I cannot detect in these the minute

[1] Quarterly Journal of the Geological Society, vol. iv, p. 67.

tubular structure which is characteristic of the group, yet its absence is fully accounted for by the metamorphic condition of the shell, a like obliteration having occurred in fossil *Discinæ* and *Lingulæ*.

In bringing to a conclusion the present account of the structure of the shell in this most interesting group of Mollusca, I cannot but express my regret that it has not lain in my power to render it more complete. Those who seek for assistance in classification from the characters which I have furnished, will, I fear, complain with much reason of the small proportion of species which I have submitted to examination, especially in some of those generic types (as *Spirifer*, *Athyris*, and *Orthis*) whose variability in this respect makes such an examination especially important. I may be permitted to remark, however, that the labour of preparing microscopic sections (the only mode, as I have shown, which can give satisfactory results in regard to fossil *Brachiopods*) is by no means trifling, and that the results here given are based on the examination of no fewer than *three hundred* such preparations. No doubt, I venture to think, can now remain as to the importance, as a natural-history character, of the perforation or non-perforation of the shell, for the reception of the vascular processes of the animal,—a feature in its structure which I may claim to have been the first to demonstrate; and I must leave the more extensive determination of it, as regards individual species, to be carried out by those who possess more time and opportunity for such a work than I can command.

CHAPTER III.

ON THE CLASSIFICATION OF THE BRACHIOPODA.

By THOMAS DAVIDSON, F.G.S., &c.

Sub-Kingdom—MOLLUSCA, *Cuvier.*

Class—BRACHIOPODA, *Cuvier.*[1] *Dumeril.*[2]

Order—PALLIOBRANCHIATA, *Blainville.*[3]

The account of the gradual progress of researches in this class having been already detailed by Baron Von Buch,[4] Messrs. d'Orbigny,[5] King,[6] de Verneuil,[7] Gray,[8] M'Coy,[9] de Koninck, and others, I will pass lightly over the literature of the subject, and simply recapitulate, in a condensed shape, its most prominent features.[10]

All naturalists seem disposed to admit that Fabius Columna was the first author who called attention to some of the shells we are about to describe, and which he distinguished by the denomination of *Concha Anomya*,[11] and in his figures it is not difficult to recognize several well-known species belonging to the genera *Terebratula* and *Rhynchonella*. The *Concha Anomia* was admitted by Lister and other authors, but in 1696 Llhwyd having proposed the name of *Terebratula*[12] for the same shells, this last denomination was preferred by the generality of subsequent writers to that of Anomia, again adopted by

[1] Ann. du Mus., vol. i, p. 44; and in Roissy Moll., vol. vi, p. 460, 1805.—*Brachiopoda*, from the two variously curved and cirrated arms or labial appendages.

[2] Trait. Element., 1806.—Lamarck; Phil. Zool., 1809.

[3] Dic. des Sc. Nat., t. xxxii, p. 298, 1824.—*Palliobranchiata*, from the respiratory system being combined with the mantle, on which the vascular ramifications are distributed.

[4] Über Terebateln, 1834; and Mém. de la Soc. Géol. de France, vol. iii, 1st ser., p. 106, 1838.

[5] Considerations Zool. et Géol. sur les Brach. Pal. Franç. Ter. Crétacés, vol. iv, p. 281, 1847.

[6] Ann. and Mag. of Nat. Hist., vol. xviii, July, 1846; and a Monograph of English Permian Fossils, p. 67, 1849.

[7] Geol. of Russia, vol. ii, 1845.

[8] Ann. and Mag. of Nat. Hist., p. 435, 1848; and Cat. of the Brach. in the Brit. Mus., 1853.

[9] Synopsis of the Carb. Limest. Fossils of Ireland, p. 102, 1844; and Brit. Pal. Foss. in the Cambridge Museum, 1852.

[10] The Council of the Palæontographical Society having expressed a wish that we should condense our subject as far as possible, it has been found necessary to leave out many interesting details which would have extended this introduction far beyond the limits assigned. (23d July, 1852.)

[11] De purpura, 1616.

[12] Lithophylacii Britannici Ichnographia.

Linnæus in 1758. The term *Anomia* was, however, afterwards applied to a small group of Lamellibranchiate shells, distinct from that intended by the original denominator.

In 1712, Morton had perceived the necessity of separating the plaited Terebratulæ from the smooth ones, but did not propose any distinct generic appellation;[1] and for several years after Columna's first descriptions, but little advance was made towards classification, the few known species having been allowed to remain confounded among the other shell-fish.

Cuvier, with his acute powers of perception, after having examined the animal of *Lingula*,[2] as well as the figures of the so-called *Patella Anomala* of Müller,[3] *Criopus* of Pallas,[4] and excellent illustrations of *Ter. caput-serpentis* by Gründler,[5] proposed to create for those animals a distinct class among the Mollusca, to which Dumeril applied the name of Brachiopoda; so that the History of the Order may with truth be said almost to date from the commencement of the present century; and when we look back to all that has been achieved since that short period, we may fairly hope that by the expiration of the present century, the history of the class may have nearly attained its fullest development. At the time of Cuvier's first researches, but very few species were discovered, still these had been subdivided into several excellent genera, because the differences existing between the *Terebratulæ*, *Lingulæ*, and *Craniæ* (*Orbiculæ*), had not escaped the scrutiny of early investigators.

The vast impulse given to geological researches since the year 1800, rapidly filled the collectors' cabinets with a rich harvest of new and undescribed forms, many of which, by presenting marked differences from those already known, tempted Palæontologists to augment the number of genera, from its having been found necessary *to separate that which is fundamentally different, as well as to unite that which is really similar;*[6] nor is it surprising to find in such attempts, at times conducted by inexperienced hands, that numerous errors should have taken root, which time and sub-

[1] Nat. Hist. of Northamptonshire.

[2] Mémoire sur l'Anatomie de la Lingule, 'Mém. du Mus.,' vol. i, 1802. [3] Zoologia Danica, 1781.

[4] Test. Sicil., 1792. [5] Naturforscher, vol. i, 2d part, p. 86, tab. iii, figs. 1—6, 1774.

[6] This expression is forcibly made use of by Professor M. Edwards and Jules Haime, in their excellent work on 'British Fossil Corals.' The confusion that has existed, and still exists, is chiefly caused by the value of the terms *Family*, *Genus*, and *Species*, being by many authors viewed in a different sense; thus the *Genera* of some are the equivalents of the *Families* of others, so that a continual controversy naturally arises. The excellent observations on this point, published by Mr. Strickland, in p. 217 of his report, before the British Association for 1844, should be duly weighed and considered: he observes that, "all groups of the same rank are supposed in theory to possess characters of the same value or amount of importance, and the object of the naturalist should be, to bring them as nearly as possible to this state of equality. It must, indeed, be admitted, that no certain test seems to have been discovered for weighing the value of Zoological characters. The importance of the same characters manifestly varies in different departments of nature, and must therefore be estimated by moral rather than demonstrative evidence. The real test of the value of a structural character ought to be its influence on the economy of the living animal; but here we too often have to lament our ignorance, or our false inductions, and in many cases we are wholly unable to

sequent researches alone will remove; and because such have occurred in the infancy of the science, ought we to cancel all that fifty years of arduous researches has brought to light, and retrace our steps, as some would wish, to the period of Linnæus? *No one has, as yet, nor will any one for some years to come, be able to produce a complete and satisfactory classification of the numberless species and varieties composing the order;* because, to hope to arrive at such a condition, it is absolutely necessary to be thoroughly acquainted with the interior arrangement and other characters of *all the species* one has to classify, and I am sorry to say we are still *very far* from having attained so desirable a state; all we can do, therefore, in the mean time, is to assemble conscientious observations, and gradually improve the general views in circulation at the time being.

Soon after the publication of Cuvier's discoveries, several new and excellent genera were from time to time introduced by Sowerby, Lamarck, Defrance, Fischer de Waldheim, Dalman, and others, which, with their dates and synonyms, will be found recorded under the heads of the different genera.

In 1818, Lamarck regarded the Brachiopods as forming the greater part of his 3d section of the Conchifères Monomyaires:—

1. Les Rudistes. 1, *Spherulite;* 2, *Radiolite;* 3, *Calceole;* 4, *Birostrite;* 5, *Discine;* 6, *Cranie.*
2. The Brachiopoda. 1, *Orbicule;* 2, *Terebratule;* 3, *Lingule.*[1]

In 1824, M. de Blainville placed at the head of his Acephalophores an order, which he named *Palliobranchiata*, as a substitute of *Brachiopoda.*[2] He divides this order as follows:—

1. Symmetrical Shells, *Lingula, Terebratula, Thecidea, Strophomena, Plagiostoma, Dianchora, and Podopsis.*

2. Unsymmetrical Shells, *Orbicula* and *Crania.* The genus *Calceola* he places in

detect the relations between structure and function. More definite principles of classification may hereafter be discovered, and meantime all that we can do is to arrange our systems according to sound reason, and without theoretical prepossession. By care and judgment much may be done to give greater regularity and exactness to our methods of classification, either by introducing new groups where the importance of certain characters requires it, or by rejecting such as have been proposed by others on insufficient grounds. At the present day, many authors are in the habit of founding what they term *new Genera* upon the most trifling characters, and thus drowning knowledge beneath a deluge of names. . . . In the sub-dividing of larger groups into genera, even in the strictest conformity with the natural method, there is evidently no other rule but *convenience* to determine how far this process shall be carried. . . . Nature affords us no other test of the just limits of a genus (or indeed of any other group) than the estimate of its value which a competent and judicious naturalist may form. The boundaries of genera will therefore always be liable to fluctuate. . . . The only remedy for this excessive multiplication of genera is for subsequent authors, who think such genera too trivial, not to adopt them, but to adopt the old genus in which they were formerly included."

[1] Hist. des Animaux sans Vertèbres.

[2] Dic. des Sciences Nat., t. xxxii, p. 298; and Manuel Malac., &c.

his second order, Rudistes; but, as justly observed by the author of the 'Paléontologie Francaise,' De Blainville's classification varies but little from that by Lamarck; and one is at a loss to imagine what relation the celebrated malacologist could have found between *Plagiostoma*, *Dianchora*, and *Terebratula*. To the present day some authors are disposed to consider the *Rudistes* as a portion of the Brachiopoda.[1] While others, and by far the greater number, repudiate such a conclusion.[2]

Eight or nine years after the publication of M. de Blainville's observations, Baron Leopold von Buch issued his very remarkable work on the 'Classification of the Terebratulæ;'[3] which materially contributed to the subsequent advancement of the science. The Baron, founding his arrangements on the position and shape of the foramen, establishes two principal divisions. In the first he places those forms attached by a pedicle issuing between the valves (*Lingula*), those with one valve perforated (*Terebratula Delthyris*), and those which he considers to be imperforated (*Calceola* and *Leptæna*). In the second division he admits those species presenting a perforation through the middle of the lower valve (*Discina*), or fixed by the substance of the same (*Crania*).

About the same period, or shortly after, M. Deshayes proposed to divide the Brachiopoda into two groups. In the first he included the *articulated*, in the second the *unarticulated* species;[4] but while geologists and conchologists were thus busily engaged framing classifications on mere external and often deceptive appearances, our celebrated anatomist, Professor Owen, was at work on the animal of some of the recent species,[5] which tended to consolidate and improve the foundation of the science by bringing to light important zoological evidence.

From 1834 to 1844[6] no very important change took place in the nomenclature, but many new forms and interiors had been discovered which increased our knowledge of the genera then existing, and pointed out the necessity for the creation of several others which were introduced with more or less success by Prof. M'Coy, M. de Verneuil, Prof. King, M.

[1] Among these we may mention Goldfuss, D'Orbigny, Gray, &c.

[2] M. Deshayes strongly opposes the annexing of the Rudistes to the Brachiopoda.

[3] Since the Baron's researches much additional information has been obtained regarding the mode of existence in the different species, and it seems now generally admitted, that no satisfactory arrangement can be framed on the single evidence of the above-mentioned character. All Brachiopoda have lived either free or fixed to submarine bottoms, by the means of a muscular pedicle, or by the substance of their lower valve. Some species were attached during all their existence, others only when young, dispensing with their attachment at a more advanced stage of life; and in many examples of the same species the aperture is entirely cicatrized in the adult.

[4] Nouv. ed. des Anim. sans Vert. de Lamarck, vol. vii, 1836.

[5] Trans. of the Zool. Soc., vol. i, 2d part, p. 141, 1835; and Ann. des Sciences Nat. Zool., vol. iii, p. 315, 1845.

[6] In M. Deslongchamp's 'Tableau Synoptique d'un Arrangement Systématique des Brachiopodes Fossiles du Calvados,' 1837: the perforation and deltidium are the chief characters made use of in this classification. In 1841, Professor Phillips proposed the following arrangement of the Brachiopoda,

d'Orbigny, Mr. Sharpe, M. Bouchard, and others. It was also in 1844 that Dr. Carpenter's first important investigations on the shell structure appeared;[1] and in 1846 Professor King proposed to arrange the PALLIOBRANCHIATA into ten families and twenty-two genera, viz.:[2]—

Fam. OBOLIDÆ Genus. *Obolus.*
,, LINGULIDÆ. G. *Lingula.*
,, ORBICULIDÆ. G. *Orbicula.*
,, CALCEOLIDÆ. G. *Calceola.*
,, STROPHOMENIDÆ. G. *Strophomena, Orthis, Leptæna, Chonetes*
,, PRODUCTIDÆ. G. *Productus, Strophalosia.*
,, TEREBRATULIDÆ. G. *Terebratula, Hypothyris, Pentamerus, Camarophoria, Uncites.*
,, SPIRIFERIDÆ. G. *Spirifer, Atrypa, Martinia, Strigocephalus.*
,, THECIDEIDÆ. G. *Thecidea.*

in his 'Figures and Desc. of the Pal. Fossils,' p. 54, but the author did not completely apply his own views:

"BRACHIOPODA—

Valves free; attachment by exserted muscle.	
Valves equal	*Lingula.*
Valves unequal; larger valve imperforate (Athyridæ).	
No cardinal area	*Producta.*
A cardinal area	*Calceola.*
Large valve perforated in or under the beak.	
Perforation reaching to the hinge line (*Delthyridæ*)	
Cardinal area more or less common to both valves . . .	*Orthis.*
Cardinal area confined to the larger valve.	
Internal plates of the larger valve separate	*Spirifera.*
Internal plates of the larger valve united on the mesial line of the shell.	
Plates narrow	*Strigocephalus.*[a]
Plates very broad	*Pentamerus.*
Cardinal area obsolete, beak incurved over a minute perforation, which is often obtect, or merely serves to receive the beak of the smaller valve .	*Cleiothyris.*[b]
Perforation not reaching to the hinge line (*Cyclothyridæ*[c])	
Beak truncate, perforate	*Epithyris.*
Beak acute, the perforation below it	*Hypothyris.*

[a] The difference between *Strigocephalus* and *Pentamerus* appears to me not very important!

[b] The term Atrypa (α, privative, and τρυπα, foramen,) is objectionable; Cleiothyris (κλειω, claudo, θυρα, janua,) would be preferable, and with the terms *Epithyris* and *Hypothyris* might console us for the loss of *Terebratula,* which in Von Buch's view includes the three groups.

[c] In the sense of encircled."

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[1] Report of the British Association for 1844 and 1847.

[2] Annals and Mag. of Nat. Hist., vol. xviii, p. 83, 1846, at which period the learned Professor likewise published his views on the muscular system in *Terebratula.*

And in the same year, Mr. Morris published his interesting paper *on the subdivision of the Terebratulæ*.[1]

In 1847, M. d'Orbigny presented his views on the classification of the Brachiopoda,[2] chiefly founded on the presence or supposed absence of labial appendages in some of the species, and therefore divides the class into two orders, I. Brachidæ; II. Cirrhidæ; but from perhaps not having been able to study the animal of *Argiope* and *Thecidea*, or mistaking the brachial disk of the two last-named genera for the mantle, unites them most improperly to the Rudistes which constitute his *second order;* both *Argiope* and *Thecidea* are essentially related to the *Terebratulidæ*, or to his first division of True Brachiopoda. M. d'Orbigny's arrangement is as follows:—

I. ORDER—BRACHIOPODES BRACHIDES (*Brachidæ*).

1. Fam. Lingulidæ. Genus 1, *Lingula;* 2, *Obolus.*
2. „ Calceolidæ. G. 1, *Calceola.*
3. „ Productidæ. G. 1, *Productus;* 2, *Chonetes;* 3, *Leptæna.*
4. „ Orthisidæ. G. 1, *Strophomena;* 2, *Orthisina;* 3, *Orthis.*
5. „ Rhynchonellidæ. G. 1, *Hemithyris;* 2, *Rhynchonella;* 3, *Strigocephalus;* 4, *Porambonites.*
6. „ Uncitidæ. G. 1, *Uncites;* 2, *Atrypa;* 3, *Pentamerus.*
7. „ Spiriferidæ. G. 1, *Cyrtia,* 2, *Spirifer;* 3, *Spiriferina;* 4, *Spirigerina;* 5, *Spirigera.*
8. „ Magasidæ. G. 1, *Magas;* 2, *Terebratulina.*
9. „ Terebratulidæ. G. 1, *Terebatula;* 2, *Terebratella;* 3, *Terebrirostra;* 4, *Fissurirostra.*
10. „ Orbiculidæ. G. 1, *Siphonotreta;* 2, *Orbicella;* 3, *Orbiculoidea;* 4, *Orbicula.*
11. „ Cranidæ. 1, *Crania.*

II. ORDER—BRACHIOPODES (*Cirrhidæ*).

1. Fam. Thecidæ. G. 1, *Megathyris;* 2, *Thecidea.*
2. „ Caprinidæ. G. 1, *Hippurites;* 2, *Caprina;* 3, *Caprinula;* 4, *Caprinella.*
3. „ Radiolidæ. G. 1, *Radiolites;* 2, *Biradiolites;* 3, *Caprotina.*

In this plan, besides the very objectionable and wide separation of *Argiope* (= *Megathyris*) and *Thecidium* from the *Terebratulidæ*, the position of *Stringocephalus* is certainly out of place in the Family *Rhynchonellidæ*, where the author might have admitted *Pentamerus*, and by placing *Uncites* and *Atrypa* (Dalman) in the Family *Spiriferidæ* would have dispensed with his 6th division. *Magas* and *Terebratulina* should likewise have been added to the *Terebratulidæ*.

[1] Quarterly Journal of the Geol. Soc., vol. ii, p. 382, 1846.

[2] Comptes rendus de l'Acad. des Sciences, 1847.—Ann. des Sc. Nat., 3d series, Zool., vol. viii, p. 141, pl. vii, 1848.—Paléont. Franç. Ter. Crétacés, vol. iv, p. 281, 1848.—Cours Elémentaire de Pal., vol. ii, p. 79, 1852; and Prodrome.

In the same year M. Barrande divided the Brachiopoda of Bohemia into *Terebratula, Stringocephalus, Pentamerus, Thecidea, Spirifer, Orthis, Leptæna, Chonetes, Productus, Crania, Orbicula,* and *Lingula.*[1]

In 1848, Dr. Gray proposed his new arrangement,[2] dividing the class into five orders, which may be analysed as follows:—

BRACHIOPODA. 1. Sub-Class—ANCYLOPODA.

I. Order—Ancylobrachia. 1, Fam. *Terebratulidæ.*

II. Order—Cryptobrachia. 1, Fam. *Thecideidæ* (Argiope *and* Thecidea).

2. Sub-Class—HELICTOPODA.

III. Order—Sclerobrachia. 1, Fam. *Spiriferidæ;* 2, Fam. *Rhynchonellidæ, Rhynchonella, Camarophoria, Uncites? Trigonosemus, Rhynchora, Pygope, Delthyridea, Pentamerus.*

IV. Order—Sarcicobrachia. 1, Fam. *Productidæ, Productus, Strophalosia, Chonetes, Leptæna, Orthis, Strophomena,* and *Calceola.*

2, Fam. *Craniadæ.*

3, „ *Discinidæ.*

4, „ *Lingulidæ.*

V. Order—Rudistes.

Dr. Gray's scheme appears objectionable on account of the perhaps uncalled for subdivision of the class into five orders; thus, for example, the second order, *Cryptobrachia,* seems completely unnecessary. The position of several of the families and genera is also incorrect; as instances of this we find in Order III, among the *Rhynchonellidæ, Uncites,* whose place is in the *Spiriferidæ; Trigonosemus, Pygope, Rhynchora,* and *Delthyridæa,* should have been classed in the first order with the Family *Terebratulidæ,*[3] where *Argiope* ought likewise to have been admitted. *Calceola,* quite an anomalous shell among the Brachiopoda, is placed in the same family as *Productus,* although possessing none of the essential characters of the last-named genus.

In the 'Index Palæontologicus,' 1849, M. Bronn divides the class into 29 genera, several of which are, however, only synonyms.

We now arrive at Professor King's second scheme, where the learned Palæontologist adopts three of Dr. Gray's orders, and divides the class into 16 families and 49 genera, as follows:—

[1] Über die Brachiopoden aus den Naturwissenschaftlichen Abhandlungen, 1847.

[2] Ann. and Mag. of Nat. Hist., vol. ii, p. 435, 1848.

[3] These corrections have been introduced in the Catalogue of the Brachiopoda in the Brit. Mus., 1853.

Order—SARCICOBRACHIA.

1. Fam. Lingulidæ. Genus *Lingula.*
2. „ Obolidæ. G. *Obolus.*
3. „ Craniadæ. G. *Crania, Siphonotreta, Criopus.*
4. „ Discinidæ. G. *Discina, Orbiculoidea, Trematis.*
5. „ Calceolidæ. G. *Calceola.*
6. „ Davidsonidæ. G. *Davidsonia.*
7. „ Productidæ. G. *Productus, Strophalosia.*
8. „ Strophomenidæ. G. *Strophomena, Leptæna, Chonetes, Orthis, Streptorhynchus, Orthisina, Dicælosia, Platystrophia.*

Order—SCLEROBRACHIA.

9. Fam. Hypothyridæ. G. *Isorhynchus, Hypothyris, Camarophoria, Uncites, Pentamerus.*
10. „ Spiriferidæ. G. *Atrypa, Athyris, Cleiothyris, Retzia, Delthyris, Trigonotreta, Spirifer, Martinia.*

Order—ANCYLOBRACHIA.

11. Fam. Strigocephalidæ. G. *Stringocephalus.*
12. „ Terebratulidæ. G. *Epithyris, Terebratella, Terebratula, Pygope, Eudesia, Megerlia, Waldheimia.*
13. „ Rhynchoridæ. G. *Ismenia, Delthyridæa, Rhynchora.*
14. „ Magasidæ. G. *Magas, Bouchardia.*
15. „ Thecidæidæ. G. *Thecidæa.*
16. „ Argiopidæ. G. *Argiope.*

The chief objection to Professor King's arrangement lies in the sometimes great sub-division of the genera, and to which we will revert hereafter when treating the respective sections.[1]

Since the last-named publication two other schemes have been introduced by Dr. Van der Hoeven[2] and Professor Quenstedt.[3] The first of those authors admits of eight genera :—

[1] I take this occasion to express my warmest thanks to Professor King for the friendly and unreserved manner in which he has communicated to me his views, and for the liberal loan of all the specimens belonging to his collection, now forming part of the Museum of the Queen's College, Galway; and I hope that any difference of opinion I may have expressed, will be considered as having only been dictated by a desire similar to his own, viz., the advancement of science. I am happy to repeat the same, relative to Professor M'Coy.

[2] Handbuch der Zoologie, 1850.

[3] Handbuch der Petrefactunde, 1851.

Lingula, Orbicula, Crania, Calceola, Thecidea, Terebratula, Spirifer, and *Productus.* The second six, viz.: *Terebratula, Spirifer, Orthis, Productus, Lingula,* and *Thecidea.*

In 1852, Professor M'Coy divides the Palliobranchiata into two orders:[1]

1st Order. *Rudistes* (Lam.) contains three families:—1, *Thecideæ;* 2, *Caprinidæ;* 3, *Radiolidæ.*

2d Order into eleven families:—1, *Craniadæ;* 2, *Orbiculidæ;* 3, *Terebratulidæ;* 4, *Magasidæ;* 5, *Spiriferidæ;* 6, *Uncitidæ;* 7, *Rhynchonellidæ;* 8, *Orthisidæ;* 9, *Productidæ;* 10, *Calceolidæ;* 11, *Lingulidæ.*

Professor M'Coy has fallen into the same mistake as M. d'Orbigny, viz. by placing *Thecidium* among the Rudistes. In the 2d Order his 4th and 6th families may be dispensed with, the 4th belonging to the *Terebratulidæ*, the 6th to the *Spiriferidæ.*

From the above brief summary it is evident that the tendencies of some have been to multiply, others to reduce, the number of genera; this fluctuation of opinion proceeds from the different relative value or importance attributed to certain characters which are by some considered *generic,* by others only *specific.* Thus, for example, Prof. Quenstedt divides his genus *Terebratula* into 1, *Bicornes;* 2, *Calcispiræ;* 3, *Annuliferæ;* 4, *Loricatæ;* 5, *Cinctæ;* 6, *Impressæ;* 7, *Nucleatæ;* 8, *Triplicatæ;* 9, *Spiriferinæ.* Now, in my opinion, as well as in that of many other Palæontologists, his TEREBRATULÆ CALCISPIRÆ (*T. prisca* and *prunum*) and his TEREBRATULÆ SPIRIFERINÆ (*T. concentrica, tumida, ferita,* &c.) from possessing internal spires for the support of the cirrated arms, similar in essential or family character to those of *Spirifer,* would be much more naturally and properly classed under the last-named genus, and the objection to placing in the same section or family such shells or animals as *Ter. vitrea, R. psittacea, A. prisca* and *S. concentrica,* is too obvious to demand any lengthened explanations; for both the dispositions of the oral processes, and other details of the animal economy, are essentially dissimilar, and therefore could not possibly be confounded under a single denomination; otherwise the drawing up of a uniform and clear diagnosis would be impossible, and thus lead to very serious practical inconveniences. Those who have devoted serious attention to the external and internal characters of these shells, have come to the conclusion that the class is now sufficiently investigated to be susceptible of subdivision into natural groups or families, and these again into genera. Thus, for example, we are acquainted with upwards of a hundred species of *Terebratulæ,* presenting exactly the same internal dispositions, namely, *a short* simply-attached loop supporting similarly disposed cirrated arms; to such a group the same generic appellation is natural and proper; but not if likewise made to include another equally numerous series of species, in which, besides differences in the external and shell structure, we find free extensile spiral arms (*Rhynchonella*), supported only at their origin by two slender curved lamellæ. Still, according

[1] British Palæozoic Fossils, part 2, p. 186, 1852.

to Prof. Quenstedt and some others, this last group would also take place among the *Terebratulæ*, an assumption surely in opposition to zoological law.

The great difficulty seems how to establish a definite and APPLICABLE arrangement; and this question will probably continue unsolved, until our knowledge of the internal structure of the many at present ambiguous forms has been cleared up, which fortunate circumstances, time, and persevering researches can alone accomplish.[1]

The many years I have devoted to the study of the species composing this class, has tempted me to propose certain amendments and changes in the schemes already published by Prof. King, M. d'Orbigny, and others; and I do so in the hope that any steps, *however small*, towards the future settlement of a so-much controverted question, may be considered worthy of the attention of those who feel interested in the subject.

[1] A celebrated French conchologist stated some years ago, that Palæontologists could never hope to arrive at a knowledge of the interior of all the species; but since that period the numberless discoveries and well-conducted researches make us believe, on the contrary, that ere long we may become acquainted with the most delicate internal details of all those species which have hitherto resisted our endeavours. And no better example can be selected of what patience and diligent exertions can achieve, than the splendid work recently published on the 'Silurian Fossils of Bohemia,' by that eminent and justly celebrated geologist and palæontologist, M. Barrande; the author mentions, among other examples, that to obtain a perfect example of one of the most common Trilobides (*Dalmanites socialis*), it required a number of years of the most assiduous researches. Among the Brachiopoda, we may likewise quote *Stringocephalus* and *Uncites*, whose internal arrangement baffled all researches for a long period.

SYNOPTICAL TABLE, OR CLASSIFICATION OF THE BRACHIOPODA INTO FAMILIES AND GENERA.[1]

Families and Sub-Families.	Genera and Sub-Genera.	Author.	Date.	A few Types.	Geological Range now known.									
					Silurian.	Devonian.	Carboniferous.	Permian.	Triassic.	Jurassic.	Cretaceous.	Tertiary.	Present.
TEREBRATULIDÆ	Terebratula	Llhwyd	1699	*vitrea, maxillata, perovalis, diphya*	?	*	*	*	*	*	*	*	*
	Sec. A. *Terebratulina*	D'Orbigny	1847	*caput-serpentis, sub-striata, gracilis*	:	:	:	:	:	*	*	*	*
	„ B. *Waldheimia*	King	1849	*australis, lagenalis, digona, numismalis*	:	:	:	:	:	*	*	*	*
	Terebratella	D'Orbigny	1847	*chilensis, dorsata, Coreanica*	:	:	:	:	:	?	*	:	:
	Sec. A. ? *Trigonosemus*	Kœnig	1825	*elegans*	:	:	:	:	:	:	*	:	:
	„ B. ? *Terebrirostra*	D'Orbigny	1847	*lyra*	:	:	:	:	:	:	*	:	:
	„ C. *Megerlia*	King	1849	*truncata, lima*	:	:	:	:	:	:	*	*	:
	Kraussia	Davidson	1852	*rubra, cognata, pisum, Lamarckiana*	:	:	:	:	:	:	*	:	*
	Magas	Sowerby	1818	*pumilus, orthiformis*	:	:	:	:	:	:	*	:	*
	Bouchardia	Davidson	1849	*tulipa* or (*rosea*)	:	:	:	:	:	:	?	:	*
	Morrisia	Davidson	1852	*anomioides*=(*appressa*)	:	:	:	:	:	:	*	:	*
	Argiope	Deslong.	1842	*decollata, decemcostata, cuneata*	:	:	:	:	:	:	:	*	*
? Stringocephalidæ	Stringocephalus	Defrance	1827	*Burtini, giganteus*	:	*	:	:	:	:	:	:	:
Thecideidæ	Thecidium	Defrance	1828	*radiatum, digitatum, dorsatum, Klipst. sp.*	:	:	:	:	*	*	*	*	*
Spiriferidæ	Spirifer	Sowerby	1815	*striatus, alatus, Archiaci, glaber*	*	*	*	*	*	*	:	:	:
	Sec. A. ? *Spiriferina*	D'Orbigny	1847	*rostrata, cristata, Tessoni, Münsteri*	:	?	*	*	*	:	:	:	:
	„ B. ? *Cyrtia*	Dalman	1827	*trapezoidalis*	:	:	:	:	:	:	:	:	:
	Athyris	M'Coy	1844	*tumida, Herculea, scalprum*	*	*	*	:	:	:	:	:	:
	Spirigera	D'Orbigny	1847	*concentrica, pectinifera, Roissyi*	*	*	?	*	*	*	:	:	:
	Sec. A. ? *Retzia*	King	1849	*Adrieni? ferita*	*	*	*	:	:	:	:	:	:
	Uncites	Defrance	1848	*gryphus*	*	*	*	*	*	:	:	:	:
	Atrypa	Dalman	1827	*reticularis, marginalis, prunum*	:	*	*	:	:	:	:	:	:
? Koninckinidæ	Koninckina	Suess	1853	*Leonhardi*	*	:	:	:	*	:	:	:	:
Rhynchonellidæ	Rhynchonella	Fischer	1809	*loxia, acuminata, psittacea, octoplicata*	*	*	?	?	*	*	*	*	*
	Camarophoria	King	1844	*Schlotheimi, multiplicata, globulina*	:	:	?	*	:	:	:	:	:
	Pentamerus	Sowerby	1813	*Knightii, galeatus, conchidium*	*	*	*	:	:	:	:	:	:
? Porambonitidæ	Porambonites	Pander	1830	*æquirostris, reticulatus, Ribeiro*	*	:	*	:	:	:	:	:	:
Strophomenidæ	Orthis	Dalman	1827	*calligramma, ? rustica, elegantula*	*	*	*	:	:	:	:	:	:
	Orthisina	D'Orbigny	1849	*adscendens, anomala, hemipronites*	*	*	*	*	:	:	:	:	:
	Strophomena	Rafinesque	1825 ?	*planumbona, alternata, analoga*	*	*	*	:	:	:	:	:	:
	Leptæna	Dalman	1827	*transversalis, Davidsoni, oblonga*	*	*	*	?	*	*	:	:	:
? Davidsonidæ	Davidsonia	Bouchard	1849	*Verneuili, Bouchardiana*	:	*	*	:	:	:	:	:	:
Productidæ	Chonetes	Fischer	1837	*sarcinulata, lata, concentrica*	*	*	*	*	:	:	:	:	:
	Strophalosia	King	1844	*excavata, Morrisiana, Gerardi*	:	*	*	*	:	:	:	:	:
	Sec. A. ? *Aulosteges*	Helmersen	1847	*Wangenheimi*=(*variabilis*)	:	:	:	*	:	:	:	:	:
	Productus	Sowerby	1814	*semireticulatus, Martini, horridus*	?	*	*	*	:	:	:	:	:
Calceolidæ	Calceola	Lamarck	1809	*sandalina*	:	:	*	:	:	:	:	:	:
Craniadæ	Crania	Retzius	1781	*Brattenburgensis, anomala, costata*	*	*	*	*	*	*	*	*	*
Discinidæ	Discina	Lamarck	1819	*lamellosa, striata, Cumingii*	*	*	*	*	*	*	*	*	*
	Sec. A. ? *Orbiculoidea*	D'Orbigny	1847	*elliptica, Forbesii*	*	:	:	:	:	:	:	:	:
	„ B. ? *Trematis*	Sharpe	1847	*terminalis, cancellata*	*	:	:	:	:	:	:	:	:
	Siphonotreta	Verneuil	1845	*unguiculata, verrucosa, anglica*	*	:	:	:	:	:	:	:	:
	Sec. A. ? *Acrostreta*	Kutorga	1848	*subconica, disparirugata, recurva*	*	:	:	:	:	:	:	:	:
Lingulidæ	Lingula	Bruguière	1789	*anatina, Dumortieri, Beanii*	*	*	*	*	*	*	*	*	*
	Obolus	Eichwald	1829	*Apollinis, sculptus, transversus*	*	:	:	:	:	:	:	:	:

[1] For figures, refer to Introduction, Pls. I to IX.

All naturalists are aware that linear arrangements do not occur in nature, therefore the present as well as all similar attempts must be viewed as artificial, and more or less conventional; our endeavours have, however, tended to group together those animals which in the present state of our knowledge seem to possess essential similarity of character, and have, therefore, provisionally divided the class into ten families and four sub-families; but it must be observed that when Palæontologists are better acquainted with the internal characters of the genera and species, the limits, as well as the number of the groups, will most probably require modification, and the more so since those forms located for the present in *sub-families* have not been sufficiently worked out to warrant their admission in the groups already defined. No small amount of investigation has taken place in the endeavour to find out *what principle* or *what characters* should be considered of sufficient importance to authorise the separation of families and *genera;* the difficulty will be easily understood when it is remembered that out of forty *sections* or *sub-sections* here introduced, fourteen alone possess living representatives, and the animal of several of these last has not hitherto been completely anatomically examined. The difficulties, therefore, naturally increase in those cases, unfortunately by far the most numerous, where all that can be gathered of the inhabitant of the shell consists in a few impressions existing in the interior of the valves. The study of the animal of *Terebratula, Crania, Discina, Lingula,* and a few other recent types, has to a certain extent opened the way to a knowledge of portions of the animal of many extinct genera, and it is by analogy and careful comparisons that modern Palæontologists have perceived the absolute necessity of separating certain things which early naturalists had confounded together, from not being able to interpret or understand the use or importance of the calcified processes or impressions visible in the interior of the shell.

All Brachiopoda are possessed of two valves *articulated* by the means of teeth and sockets, or *unarticulated,* and kept together entirely by muscular action. Out of the forty-five sections or sub-sections enumerated, thirty-three are distinctly articulated, but in one of the most natural groups, viz. that of the *Productidæ,* we find genera presenting both conditions. The animal of the *Brachiopoda* lived entirely free, or was fixed to marine bottoms during a part or the whole of its existence either by the substance of a portion of the ventral valve, or by the means of a muscular peduncle passing between the valves, or through an aperture existing in the ventral or dental valve, it is probable that the majority of the species were fixed, at least in an early stage of their existence, however much they may have dispensed with that temporary attachment at a more advanced period. In the same family and even genus, however, we discover forms which had been attached, while others present no traces of such a condition. It would, therefore, be impossible to separate the *attached* and *unattached* species, genera, and families, from this character alone. The shape and position of the *foramen,* or its absence, when combined with other peculiarities, may help to define and circumscribe certain groups. The value to be attached to the *shell structure* has already been ably discussed by Dr. Carpenter, that we need only remind our

readers of the fact that certain families are entirely composed of *punctated*, others of *unpunctated* species, while a few are made up of genera, which seem to assume both conditions. *Spinose* and *foliaceous* expansions cannot be considered of generic importance, since they occur in some species of most genera.

Coloration cannot be made use of as a generic character, and its value to the Palæontologist is small; but when occurring on fossil forms it should always be noted. Prof. Forbes has kindly informed me, "that his observations on the distribution in depth of recent species have led him to the conclusion that definite patterns, *i. e.*, stripes, bands, and waves of colour vividly marked, do not occur, except in rare instances, on shells living beyond moderate depths, as below fifty fathoms or thereabouts, and that thus we may be enabled to come to approximate conclusions respecting depths of ancient seas from the patterns preserved to us on fossil shells." The coloration is of some use in distinguishing the recent forms of Brachiopoda, green, yellow, red, and blueish-black being the prevailing colours; several forms are striped or spotted with red. Among the fossil species some examples have preserved traces of their colours, as already mentioned in Part III, p. 6, and several other examples will be hereafter noticed, so that in all probability the species now extinct, when alive, presented all the rich varieties of tint observable in the present inhabitants of our seas.

Muscular Impressions.—We will now briefly notice those impressions left by the muscles in the interior of the shell in the different genera. The character of several of these in *Lingula*, *Discina*, *Crania*, *Terebratula*, and *Rhynchonella*, had been pointed out in 1802 and 1833 by Cuvier and Prof. Owen, but since that period considerable progress has been made, and we are already sufficiently acquainted with the bearing of the majority of these in the forms now alive to venture to interpret their homologues in the fossil, *extinct genera;* but further researches on the function of certain of these, especially in *Lingula*, *Discina*, and *Crania* will be necessary before the subject can be considered completely and finally settled.

Professor Owen has made known his most recent views on the muscular system of *Terebratula* in the first chapter of this Introduction.[1]

Three kinds of muscular impressions particularly interest the Palæontologist.

I. The Adductor (*valvular muscles* of King, *Adductor longus, anticus*, and *posticus*, of Professor Owen) leaves in the *dorsal* or *socket valve* of all the articulated genera four

[1] The account which I have given of the muscular system of the recent Brachiopoda is also derived from a personal examination of the animals of all the recent genera, aided by the important Memoir of Professor Owen, in the 'Zool. Trans.' for 1833, and that of Professor King, in his work on the 'English Permian Fossils,' published by the Palæontographical Society in 1849. These examinations, and their application to the muscular impressions in the *extinct* genera, were made in conjunction with Mr. Woodward, (as stated in the 'An. Nat. Hist.' for May, 1852).

Since then, Professor Owen kindly offered to publish, in my Introduction, the valuable materials accumulated in his researches during the last twenty years; but after comparing the learned professor's printed proof with my own, I find that he has given to some of the muscles names differing from those

impressions at times divided by a *dorsal mesial* plate ; and a glance at the figures introduced in Plates VI, VII, VIII, and IX, will explain their position and modifications in the different genera better than could be done by a lengthened description.

The muscular fibres that produce this quadruple impression, after converging to near the centre of the *ventral* or *dental valve*, are there fixed, and produce a *single impression* (at times divided) ; but in some species of *Spirifer*, such as *S. rostratus*, *Munsteri*, &c., where there exists a largely developed ventral septem, the base of which occupies the whole space generally devoted to that muscle, its attachment is then shifted to the upper sides of the plate, as represented in Pl. VI, fig. 60.

which I employed, and which, as our plates are printed, it is now impossible to harmonize except by the following comparison here added to assist the reader :

Prof. Owen.		Davidson.
Adductor longus anticus *Adductor longus posticus*	=	*Adductor muscle.*
Adductor brevis	=	*Cardinal muscle.*
Cardinalis	=	*Accessory cardinal.*
Retractor superior *Retractor inferior (of the Peduncle)*	=	*Pedicle muscles* { *Dorsal.* / *Ventral.*

From the above, it will be seen that I used Professor King's term *cardinal muscles* for Professor Owen's *adductor brevis* and *cardinalis*. The term *pedicle muscles* (which I divide into *dorsal* and *ventral*) appeared to be a name which it was very desirable to retain, and I find that the distinguished Hunterian Professor admits, in p. 8, that his *retractor superior* and *inferior* are essentially *peduncle muscles*.

In the 'Ann. and Mag. of Nat. Hist.' for July, 1846, Professor King enters into the following details relative to the muscular system of *Terebratula*, "in order that the use of certain parts to be mentioned hereafter may be properly understood. From a specimen of *T. dorsata*, at present before me, containing the entire muscular system desiccated, and freed of the visceral mass, I have drawn up the following details :—The rostral or umbonal cavity is occupied with a dense fibrous cylindrical body called the pedicle ; considering the convexity of the foraminal valve, as the upper side of the shell, the inferior end of the pedicle fits into the foramen ; while its superior end, which is somewhat flattened or dilated in the transverse direction of the shell, is situated at the entrance or anterior part of the rostral cavity, to the surface of which it appears to be attached by means of tendinous or membranous cords : the truncated extremity of the pedicle itself not being adherent. A little in advance of the upper extremity of the peduncle, three pairs of muscles pass off to different parts, the outermost pair (which consist of those muscles implanted nearest the lateral margins of the valve), passes at a slight angle into the upper part of the pedicle : within these muscles, and somewhat in front of them, another pair passes downwards (slightly converging at the same time), and becomes attached to a flattened prominency, situated in the centre of the hinge of the lower or imperforate valve. To distinguish these pairs of muscles from each other, it will be necessary to name the former the *superior pedicle muscles*, and the latter the *cardinal muscles*. In close proximity to the superior end of the pedicle, and a little behind, and within the cardinal muscles, and therefore near the medio-longitudinal line of the shell, is situated the origin of the remaining pair, which passes directly down to a little behind the centre of the opposite valve, each muscle at the same time becoming dichotomous in its inferior half; these may be termed the *valvular muscles*. Besides supporting the cardinals and the valvulars, the imperforate valve affords attachment to other two muscles which pass upwards from the *crural base* (where each one is divided), and become inserted in the upper part of the pedicle : it is proposed to name these, the *inferior pedicle muscles*. With one exception, the foregoing description agrees with that

II. The position of the *Cardinal muscle* of King (*Adductor brevis* of Prof. Owen) is always recognisable in the interior of the articulated genera. In the *ventral* or *dental valve* it leaves two large pyriform scars always clearly defined, and extending somewhat in advance of the confluent insertion of the *Adductor*. In passing to the opposite valve the two divisions of this muscle converge and are fixed in the *dorsal* or *socket valve* to a *Cardinal process* (*boss* of King), which varies to a very remarkable extent in certain *Terebratulidæ, Stringocephalus, Camarophoria, Orthis, Strophomena productus* &c., while in some forms, from the non-development of this process, the muscular attachment to that valve is less clearly defined. In the un-articulated genera, *Discina* and *Crania*, the equivalent of the cardinal muscle has not been ascertained with certainty; it is perhaps the *sliding muscle* of Professor Owen.

given by Professor Owen, in his 'Memoir on the Anatomy of the Brachiopoda' (1833), in which it is stated that the muscles which have been termed valvulars pass into the upper part of the pedicle—a statement which I am led to suspect may have arisen simply from the superior termination of these muscles, in the specimens examined by this distinguished anatomist, being so close to the upper part of the pedicle as to appear as if attached to it." In 1849 Professor King diagramatically represented the *muscular* system of *Ter. australis*, and the position of our *adductor* and *cardinal* muscles (*adductor longus* and *brevis* of Professor Owen) is clearly exposed ('English Permian Fossils,' pl. xx, figs. 10—12). Professor Owen likewise states, that in the year 1846 he left for publication at Naples most of the details on the muscular system he has introduced in the first chapter of this Introduction. In a very useful and interesting manual on the 'Mollusca,' published by Mr. S. P. Woodward (1851), a figure of *Ter. australis* is given (p. 8) in which the *retractors* (cardinal muscles) are there termed for the first time (to my knowledge) "muscles by which the valves are opened." However, one year after (1852), Professor M'Coy states in his 'British Pal. Fossils in the Cambridge Mus.,' p. vii of the advertisement, and p. 191 of the letter-press, that he had discovered "that the valves of Terebratula were opened by the action of a pair of muscles, which arise from the middle of the perforated or receiving valve, and the tendons of which are inserted into the internally prolonged entering beak of the entering valve, which thus forms a lever moving on the hinge-teeth as a fulcrum." I have not, however, been able to find where the learned author had published these discoveries, which to claim priority must have been made public before 1846.

In the short zoological account of the Brachiopoda, published by the learned author of the 'Paléont. Française,' in the 'Annals des Sciences Nat.,' vol. viii, 1847, some of the muscles seem to have been incorrectly described.

To conclude this account of the views hitherto published on the muscular system of the genus *Terebratula*, we may mention, that in Dr. Gray's 'Catalogue of the Terebratulæ in the British Mus.' (1853), two diagrams by Mr. Woodward illustrate the muscular impressions in the *Ter. australis*, and which we have reproduced with Dr. Gray's permission, in p. 64, figs. 6, 7. The woodcut here appended (fig. 1), was likewise drawn for Dr. Gray by Mr. Albany Hancock, to which were attached the following explanations: *a, adductors; r, retractors; x, accessory retractors; p,p, pedicle muscles; z, function uncertain; o, mouth; v, vent; l, loop; t, dental socket.*

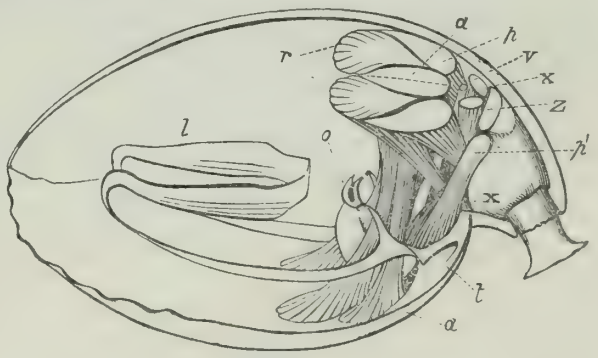


Fig. 1. *Waldheimia flavescens.*

Our *Accessory cardinal muscles* (*Cardinalis* or *hinge muscles* of Prof. Owen) produce very slight impressions on the internal surface of the shell; their position is represented at (*x*) in figs. 7, p. 64, and 1, p. 55, but seems to have been omitted in Prof. King's diagram, illustrating the muscular system in *Ter. australis*. ('English Permian Fossils,' Pl. XX.)

III. *The pedicle* muscles (*retractor superior* and *inferior* of Prof. Owen) have often but not always left impressions in the interior of the valves; they are wanting in those forms which appear to have lived free, or to have been but slightly attached in the early part of their existence. It is likewise worthy of remark that commonly the peduncle muscular impressions are more clearly defined in those species where the peduncle and the foramen for its passage is comparatively large. The *pedicle* muscles may be designated as follows:—

1. *Ventral pedicle muscles* (*retractor inferior* of Prof. Owen) form two scars exterior of the *adductor*, and can be traced in the interior of the *ventral valve* of all the *Terebratulidæ* in *Athyris, Spirigera, Atrypa, Rhynchonella*, &c.

2. *Dorsal pedicle muscles* (*retractor superior* of Prof. Owen) produce two or four recognisable impressions in the *dorsal valve*, especially in those species provided with a *hinge plate*, such as *Waldheimia, Terebratella*,[1] *Magas, Spirigera*,[2] &c. They are likewise observable in a similar position in *Rhynchonella, Atrypa, Strophomena*, and some others, where the *hinge plate* is less developed, and in which it is divided into two portions by a furrow.

In the unarticulated forms (*Productus* and *Aulosteges* excepted[3]) the muscular impressions appear more complicated, and by them *Lingula, Crania, Discina*, and others may be distinguished; but from the want of sufficiently well-preserved animals, the function and character of all these have not been as yet completely or clearly made out, nor can we add anything to what was published in 1802 and 1833 by Cuvier and Prof. Owen.

In *Discina* for example, eight muscular impressions can be distinctly traced in each valve; the posterior pair in the *perforated* or *ventral valve* lie on either side of the inner disk near the foramen, while the anterior two are situated further down towards the centre of the shell. In the upper or *dorsal valve* the posterior scars are placed nearly horizontally, at a short distance from the margin, and seem much smaller than the anterior ones, which lie obliquely near the centre of the valve; two other thin pair of diverging muscles, destined to affect the sliding of the one valve over the other, have likewise left impressions in the interior of the shell.

[1] In some species, such as *T. spathulata* and *Davidsoniana* (De Kon.), the hinge plate occupies almost all the breadth of the hinge line, and is divided into four large concave spaces for the dorsal peduncle muscles.

[2] These four pits are beautifully exhibited in the hinge plate of *Spirigera concentrica*. (See Pl. VI, fig. 66.)

[3] These two genera, although unprovided with teeth and sockets, possess a straight hinge line, and present impressions of the *adductor* muscles essentially similar to those seen in all the other articulated genera; the *cardinal process* never performs the function of a *hinge-tooth*, as was erroneously supposed by several authors.

Very remarkable differences in the *vascular impressions* left by the mantle on the inner surface of the shell have been observed, and this subject deserves much more minute investigation, in order to be used as a substantial character in the distinction of families.

It now remains for us to examine what results may be obtained from the characters afforded by the labial appendages or cirrated arms, the most important portions of the animal in the Brachiopoda; and I have little doubt that in them will be found the best character for distinguishing the great families as well as most of the genera;[1] but in order to better appreciate some of these dissimilarities, we will successively and briefly pass in review the principal modifications they assume in the different families, reserving all details connected with the genera for that portion of the introduction which treats of them in particular.

1. In the Terebratulidæ the cirrated arms[2] are variously twisted or folded upon themselves, and connected, to a greater or lesser extent, by a membrane, becoming free only at their spiral ends.[3] These labial appendages are always more or less supported by a calcified lamellar process, which assumes various shapes, but more commonly that of a loop, which is either simply fixed to the hinge plate, or likewise so to a medial septum in the dorsal valve. From differences observable in the shape and character of this kind of internal skeleton, the family may be readily and conveniently sub-divided into the following sections or sub-sections, *Terebratula*, *Terebratulina*, *Waldheimia*, *Terebratella*, *Megerlia*, *Kraussia*, *Magas*, *Bouchardia*, *Morrisia*, and *Argiope*.

2. Stringocephalus has been provisionally placed in a sub-family, of which it is the only member, on account of its peculiar organisation; the exact character of its oral appendages has not hitherto been completely elucidated, but from the discoveries made by

[1] M. d'Orbigny justly attaches great importance to characters derived from the arms in the classification of the Order.

[2] Commonly described as "*ciliated*" arms; but the term *cilia* ought to be restricted to the microscopic vibratile organs, described by Dr. Grant and Prof. Sharpey.

[3] Baron von Buch mentions that Otto Frederic Müller having dredged from the lake of Dræbach, in Norway, a number of *Terebratulæ* (*probably belonging to Rhynchonella psittacea*), and placed them in a glass of water, he observed that they gracefully extended their spirally coiled arms. Professor Owen and M. Phillipi appear not to have watched the actions of any Brachiopoda in the living state; but from the examination of preserved specimens, they have arrived at the conclusion, that they were able to unfold the spiral portion of their arms. Professor Forbes, who has frequently dredged living *Terebratulæ* on the coasts of Scotland, and also in the Mediterranean, when describing the animal of *Terebratulina caput-serpentis* ('History of British Mollusca'), states that the arms themselves *cannot be protruded*. The exact resemblance of these arms to the calcareous spiral appendages of *Atrypa* and *Spirifer*, led me to doubt the accuracy of the observations made nearly a century ago, by the excellent naturalist quoted by Baron v. Buch, and to suppose that the canal and muscular fibres of the oral arms might be intended to inject the *cirri*, and not to protrude the arms themselves; but I may have been mistaken in my suppositions. Through the kindness of Mr. Cuming, Mr. Woodward and myself were enabled to examine these beautiful appendages in the *R. nigricans*, dredged alive by Mr. F. J. Evans, R.N., in Foveaux Straits, about five miles N.E. of Ruapuke Island, New Zealand (19 fathoms); and after having forcibly extended the arms, we were able to count the coils, which numbered eight or nine.

Prof. King and M. Suess it seems evident that the arms were largely supported by a remarkable process somewhat in the shape of a loop, but from the inner edge of which numerous lamellæ branched off. The place this genus should occupy in the classification must therefore remain unsettled until a complete knowledge of the calcified process has been attained.

3. In the Thecideidæ the oral arms have not been as yet perhaps completely understood, and it will be very desirable to examine fresh examples of the animal of the only species we now find alive. In the greater number of fossil forms there exists a more or less complicated disk variably grooved for the reception of a peculiar loop or apophysary ridge which seems to become free near the visceral cavity; but other important peculiarities in the general habit of the genus *Thecidium* has necessitated its separation from the *Terebratulidæ*, to which it appears allied in many respects. Important discoveries recently made by M. Suess, of Vienna, may cast additional light on this group, which is so particularly worthy of the attention of the Palæontologist.

4. The Spiriferidæ may be easily and clearly characterised by the largely-developed spiral lamellæ which form two horizontal or vertical cones filling the greater portion of the shell, and no doubt supported spiral cirrated arms: but we may likewise infer from the extent of these processes that the oral appendages were not extensile, as may possibly have been the case in *Rhynchonella*. Two principal modifications in the position and direction of the spires have been ascertained, that common to *Spirifer*, and the other to *Atrypa* of Dalman (*reticularis*, *marginalis*, *prunum*, &c.,) various other details of internal arrangement and shell-structure have rendered desirable further subdivisions of the group, but in all the character of the *spire* prevails. Some of the species, as we have already noticed, bear a close *outward* resemblance to certain *Terebratulidæ*, but active researches have hitherto brought to light but rare instances of true *Terebratulæ* with loops in the Palæozoic epoch, and on the contrary the generality of these ancient *terebratuliform shells* were provided with calcified spires.

5. The only other genus hitherto discovered which possessed spiral processes for the support of the labial appendages, not here included among the *Spiriferidæ*, is that proposed by M. Suess under the name of Koninckina (Pl. VIII, figs. 194—198), for a shell confounded with *Productus*, but which the Viennese author found to possess spiral lamellæ somewhat similar to that of *Atrypa*, but we have not ventured to include this genus for the present in the *Spiriferidæ*, although its place cannot be far removed.

6. In the great family Rhynchonellidæ, the labial appendages seem to have been free, spiral, fleshy, perhaps extensile, and supported only at their origin by two short calcified curved lamellæ. The family includes the genera, viz. *Rhynchonella*, *Camarophoria*, and *Pentamerus*.

7. But little is known of the labial appendages in the families Strophomenidæ and Productidæ; and in the sub-families *Poramobnitidæ* and *Davidsonidæ*, the arms were in all probability fleshy and spirally rolled, evidence of which may be observed in the interior

of several species, but no developed calcified process existed for their support, and the arms were perhaps supported in a somewhat similar manner to what we observe in the *Craniadæ* and *Discinidæ*.

8. Nothing is known regarding the arms in *Calceola*, a genus completely anomalous in the class.

9. The labial appendages in the *Craniadæ*, *Discinidæ*, and *Lingulidæ*, are fleshy and spirally coiled. From this rapid examination it seems evident that the best characters for the subdivision of the class may be derived from the shape of the arms and their calcified supports; and by taking into account other peculiarities which accompany the modifications above described, one may hope to arrive in time at a rational arrangement of the numberless forms comprised in the Palliobranchiata.

The geological and vertical range of some of the genera and species has to a certain extent been alluded to by several authors, but M. d'Orbigny claims the merit of having first endeavoured to arrange the general distribution in a tabular shape.[1] He divides the sedimentary strata into 27 epochs,[2] and therein locates the genera, taking care to illustrate his views at the same time as to the numerical development of species by peculiar signs. This, like all similar attempts, must be considered as merely approximative, since fresh discoveries are every day liable to modify the limits and numerical importance we may assign to the genera, since Palæontologists are not yet able to place *all* the Palæozoic species with *certainty* in their proper places. So much confusion likewise exists in the synonyms that it would require much time and investigation to settle, if even possible, the true amount of known species. We differ from the learned author of the 'Paléontologie Francaise' in certain details regarding the first appearance and disappearance of some of the genera; and in the Table accompanying this introduction, I have endeavoured to mark the extent of development at *present* known derived from positive examination, and under each genus have only mentioned a few examples which I had thoroughly examined and known to belong to the group; the principal defect in the 'Prodrome' lately published by the French author above mentioned, as well as in all similar catalogues, consisting in the necessity of forcing into sections a number of species with whose internal character the compiler is necessarily unacquainted.

Thus, for example, M. d'Orbigny characterises his genus *Atrypa* (not of Dalman), as a shell *deprived of perforation* for the passage of a muscular pedicle, *with free extensile fleshy arms*, supported *only* at their *origin* by *two short curved lamellæ*, in every respect similar to those of *Rhynchonella*, from which the author states it to be distinguished *simply* by the (*often very questionable*) want of a foramen. He gives a list of 188 species which are stated to agree with his diagnosis, and consequently members of *his* section. Now let any one examine this list with care, and he will soon be convinced of the dissimilarity of the internal organisations there assembled; and I may boldly assert that a number of the

[1] Cours Elémentaire de Paléontologie et de Géologie Stratigraphiques, tableau ix, 1852.

[2] The exactness of such a system requires still to be proved.

species do not possess the character assigned by the author to his genus, viz.:—A great number possessed *spiral calcified* processes for the support of the arms, similar to those seen in *Tumida* and *Herculea*, and were not consequently free, such as *pisum*, Sow., *Nitida*, Hall, and a number of the species taken from M. Barrande, and which partly belong to the genus *Athyris*, M'Coy, (*Spirigera* of D'Orbigny,) while a few, such as *prunum*, from possessing vertical spires, require to be classed with the true *Atrypæ* of Dalman, or should, according to the French author's views, have been admitted into his genus *Spirigerina*. M. d'Orbigny's genus *Atrypa* is, therefore, made up of species belonging to the genus *Rhynchonella* (which he admits), as well as of others partaking of the character of his *Spirigera* and *Spirigerina*, &c. Numerous examples could be adduced to show the difficulty at present existing in the classing of many species into their true genus or place from *mere external appearances*, for, if we are to characterise a group by the presence of free extensile arms simply fixed at their origin to two slender curved processes, departing from the hinge-plates, and another by the arms being supported throughout in a peculiar manner by spiral lamellæ, forming vertical and horizontal cones, it is evident that species with the first character cannot take place along with those of the second; and experience has proved that often two forms, somewhat similar *exteriorly*, may have been inhabited by a very different animal, the one with free, probably extensile arms, the second in which that appendage was unextensile, and entirely supported by a largely-developed calcified process, &c. The only way, therefore, to be able with time to arrive at a proper and natural catalogue of *all the species*, is to examine and develop the internal dispositions of those forms as yet uninvestigated, and to gradually and carefully illustrate their characters. A great difference exists likewise on the probable periods of the first apparition and extinction of the different genera, and to this point geologists as well as Palæontologists justly attach great importance; some few genera, viz., *Lingula*, *Discina*, *Crania*, and *Rhynchonella*, appear to have traversed the whole geological vertical range; they appear in the older Silurian deposits, and with similar or but slight modifications in character, are still represented in our seas by a limited number of species. The *Terebratulæ* with short loops appear, from the present state of our information, to have first appeared during the Devonian era, since no example has as yet been pointed out in older rocks; but it is well to observe, that the genus *Terebratula* seems to have been of very rare occurrence in the Palæozoic period, and to have become truly developed only from the epoch of the Oolites to the present day. *Terebratulæ* with long loops (*Waldheimia*), as well as the other sections in the Family Terebratulidæ, appear, during the Oolitic period, and upwards; thus, for example, *Waldheimia* and *Terebratulina* are found in the *Oolitic Cretaceous*, *Tertiary*, and *present* epoch, *Megerlia* and *Argiope* only in the last three, while *Kraussia*, *Bouchardia*, and *Morrisia*, are only positively known in the present period.

Thecidium has not yet been discovered under the Oolites, and there also it seems to have attained its maximum of specific development, although not much less numerous in

the Cretaceous strata; it suddenly diminished in the Tertiary period, since only one species, likewise now alive, has hitherto been discovered. The Family Spiriferidæ, on the contrary, presents its greatest development in the early periods of the habitable world, and no genus or species with spiral lamellæ has been as yet noticed above the *Lias;* and it seems as if the spiral forms had been suddenly replaced by those provided with loops, which certainly implies a most important modification in the form and condition of the labial appendages; and it seems much more natural, and I may say proper, to place in one family all the species provided with loops, and into another all those possessed of spires. The same may be stated as regards the *Strophomenidæ* and *Productidæ*, no example of which has been found higher up than the Lias.

Viewed, therefore, in a general way, the number of sections, according to our present information, would be distributed somewhat as follows:

In the *Silurian* 22, in the *Devonian* 23, in the *Carboniferous* 16, in the *Permian* 13, in the *Triasic* 8 or 9, in the *Oolitic* 11, in the *Cretaceous* 14, in the *Tertiary* 10, in the present period 14: or, in other words, 33 genera lived during the *Palæozoic epochs*, or up to Trias included; from thence upwards to the present period, the number seems to have been reduced to about 20, of which 8 only are found in both the two great divisions; but, as above observed, every day may bring fresh changes in our *statistics*, and the views here expressed can only be looked upon as approximative, besides which a few of the sections, such as *Trigonosemus*, *Terebrirostra*, *Spiriferina*, *Cyrtia*, *Retzia*, *Aulosteges*, *Orbiculoidea*, *Trematis*, *Acrotreta*, and perhaps one or two others, require further examination before being *finally* admitted.

We will now proceed to describe each genus in detail, as far as our present information will admit.

Family—TEREBRATULIDÆ.

Animal fixed to submarine bottoms by a muscular peduncle issuing from a perforation in the beak of the larger valve; this aperture is partly surrounded by a deltidium in one or two pieces: oral appendages entirely or partially supported by calcified processes, which commonly assume the shape of a loop, variable in form and dimensions, but always fixed to the smaller or dorsal valve: shell structure always punctated.

Obs. In this natural family we have admitted seven genera and five sub-genera or sections; with the exception of two of these last, viz. *Terebrirostra* and *Trigonosemus*, which are still problematical, all other genera and sections are based on well-defined modifications in the form and position of the calcified supports of the arms.

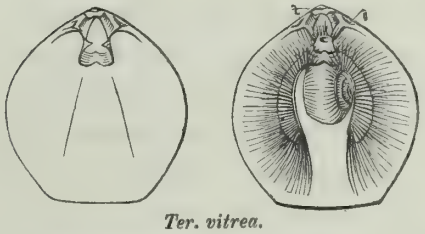
Genus—TEREBRATULA, *Llhwyd*, 1696.[1]

Type—T. VITREA, *Linn.*, sp. Introduction, Pl. VI, figs. 1—4.

CONCHA ANOMIA, (part) *Columna*, 1606 and 1616.
ANOMIA, (part) of *Linnæus, Gmelin, Da Costa, &c.*
TEREBRATULA, (part) *Llhwyd*, and the generality of authors.
LAMPAS, (part) of *Humph.*
GRYPHUS, *Megerle*, 1811. *Philippi*, 1853.
TEREBRATULITES, (part) of *Schloth.*
PYGOPE (DIPHYA), *Link.*
TEREBRATULÆ, with short loops, *Dav.*
EPITHYRIS (ELONGATA), *King.*
ANTINOMYA (DIPHYA), *Catullo.*

Shell, oval, elongated, or transverse, externally smooth or plaited, valves more or less unequally convex, margin even or waved: hinge line curved, beak short, truncated by a foramen, variable in size, and partly margined by a deltidium in one or two pieces; loop short, confined to the posterior portion of the shell, and not exceeding much more than a third of the length of the valve, simply attached to the hinge plate. The two riband-shaped lamella are soon united by a transverse lamella, bent upwards in the middle. The cirrated arms are supported by the crura, and project considerably in front of the loop: no internal septum in the socket valve.

Fig. 2. Fig. 3.



Ter. vitrea.

2. *Dorsal valve showing the loop.*
3. *Dorsal valve with the animal; the œsophagus passes through the opening of the loop.*

Obs. Some Palæontologists[2] seem disposed to consider the species with short loops as the types of the genus TEREBRATULA, and propose to place into separate *sections* or *subsections* those forms in which the calcified supports extended to near the margin before becoming reflected (*Waldheimia*), as well as those in which the crura unite in the form of a band behind the mouth of the animal (*Terebratulina*); but these sub-divisions, if of little essential value, are very convenient in the arrangement of the species, which may even be distinguished by external characters: thus in those forms with long loops, the mesial septum may easily be traced on the external surface of the smaller or dorsal valve,[3] while none such occurs in the short-looped species.

The genus *Terebratula*, as here limited, includes a vast number of species, more than a hundred having been described and figured. The dimension of the foramen is very variable, being sometimes so large as almost to admit the end of a finger, (*Ter. grandis*) while at other times it will hardly afford space for the passage of a hair. (*Ter. carnea.*)

[1] Llhwyd; Lith. Brit. Ichn., 1696, *Terebratula minor subrubra*, pl. ii, fig. 890 = *T. maxillata*, Sowerby.

[2] This view is adopted by Professor King, Dr. Gray, Mr. Woodward, and others.

[3] This occurrence was first observed by M. Deslongchamps; the length of the septum may easily be ascertained by the use of a little acid.

Geological range.—Terebratulæ with short loops are known to have lived from the Devonian epoch to the present day; they probably occurred likewise in the Silurian era, although no positively authenticated example has been ascertained.

Examples: T. vitrea, Gmelin, sp. *grandis,* Blum.; *ampulla,* Brocchi; *bisinuata,* Lamarck; *carnea,* Sow.; *obesa,* Sow.; *depressa,* Lamk.; *biplicata,* Brocchi, sp. *semiglobosa,* Sow.; *Harlani,* Morton, *sella,* Sow.; *insignis,* Schübler; *maxillata,* Llhwyd; *globata,* Sow.; *perovalis,* Sow.; *Kleinii,* Lamk.; *simplex,* Buck.; *sphæroidalis,* Sow.; *plicata,* Buck.; *fimbria,* Sow.; *diphya,* Columna, sp. *flabellum,* Def. *hastata,* Sow.; *elongata,* Schl.; *coarctata,* Park; *longirostris,* Walh.; &c. &c.

Section A, sub-genus—Terebratulina, *D'Orb.*, 1847.[1]

Type—T. caput-serpentis, *Linn.* sp. 1767. Introd., Pl. VI, figs. 7-8.

Anomia and Anomites, (part) of *Linnæus, Chemnitz, Wahlemberg,* &c.
Terebratula, (part) of the generality of Authors.
Terebratulina, *D'Orbigny.*

Shell, generally longer than wide, and more or less oval; beak obliquely truncated by a foramen, which generally extends to the umbo; deltidium small, and at times indistinct; socket or dorsal valve less convex than the perforated one, exhibiting two variably developed auricle expansions. Surface striated or costellated. Valves articulating by means of teeth and sockets; loop short, not exceeding one third of the length of the shell, and rendered annular by the union of the oral processes in the shape of a shelly band. The cirrated arms are supported by the crura and project considerably into the interior of the shell; structure punctated.

Obs. The species comprised in this sub-section are intimately allied to *Terebratula,* but differ in the union of the crural processes, which form a shelly band behind the mouth of the animal, whereas the reflected border of the loop is always in front (below in the figure) of the mouth. In young examples of the recent *T. caput-serpentis,* the crural processes are not completely joined, showing an intimate relation to *Terebratula* proper. The disposition of the cirrated arms appear the same as in *T. vitrea* and *W. australis;* they are united by a membrane, and assume the form of three lobes, the central lobe being rolled up like the

Fig. 4.

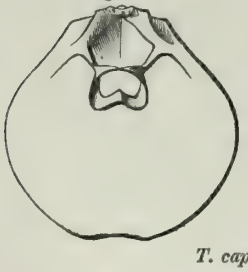
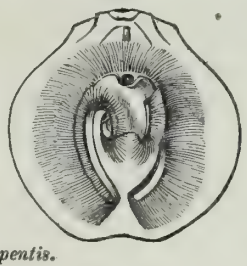


Fig. 5.



T. caput-serpentis.

4. *Dorsal valve of a young specimen, in which its oral processes are not yet completely developed.*

5. *Shell with the animal: the intestine is seen projecting above the oral aperture and fringe, the œsophagus passes through the annular part of the loop.*

[1] Considerations Zool. et Géol. sur les Brachiopodes, Comptes rendus de l'Acad. des Sciences, 1847; and Paléont. Franç. Ter. Crétacés, vol. iv, p. 56.

proboscis of a butterfly. The animal in this sub-section was well figured by Godfroy Auguste Gründler, of Halle, in 1774,[1] as mentioned both by Cuvier and V. Buch. Apart from the peculiarity of the loop, the *Terebratulinæ* form a small group so well characterised by form and sculpture as never to be confounded with any other. The beak is truncated, and the foramen partly encircled by a deltidium united or disunited in different species. The ear-like expansions on the sides of the umbo are also characteristic of this sub-genus.

Geological range.—In our present knowledge the first species appeared in the Oolitic period, and continued under different forms to the present day.

Examples: *T. caput-serpentis*, Linn. sp.; *japonica*, Sow. sp.; *cancellata*, Koch, sp.; *Cumingii*, Dav.; *striatula*, Sow. sp.; *lacryma*, Morton, sp.; *striata*, Wahl. sp.; *Gisii*, Hag. sp.; *Martiniana*, D'Orb.; *gracilis*, Schl.; *echinulata*, D'Orb.; *substriata*, Schl. sp.; &c.

Section B, sub-genus—Waldheimia, *King*, 1849.[2]

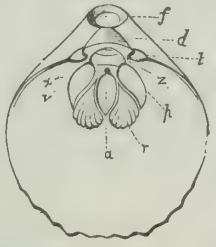
Type—W. australis, *Quoy* and *Gaim.*, sp. Int., Pl. VI, figs. 9, 10.

Anomia, (part) *Columna, Linnæus, &c.*
Terebratula, (part) *Llhwyd, Lamarck, Brug., Dav.*, and the generality of Authors.
Lampas, (part) *Humph.*
Waldheimia, *King, Gray, &c.*
Terebratulæ, with long Loops, *Dav.*

Shell, variable in shape, more or less circular sub-quadrate, transverse or elongated, with both valves convex, or with the smaller or dorsal one depressed or concave; margins straight or waved; surface smooth or plaited; beak truncated and perforated by a circular foramen of variable dimensions, partly completed by a deltidium in one or two pieces. Loop long, in general exceeding two thirds of the length of the valve, formed of slender shelly riband-shaped lamellæ simply attached by the crura to the hinge plate, and more or less folded back on itself. The cirrated arms are partially supported by this appendage, and united throughout by a membrane, exactly as in the typical species of Terebratula. The valves articulate by means of teeth situated one on each side of the deltidium, supported by plates, and fitting into corresponding sockets in the smaller or dorsal valve. In the interior of the smaller valve, a prominent cardinal process or boss, and hinge plate, with four depressions, occupies the space between the socket ridges, under which originates

Fig. 6.

Fig. 7.



f. 6, *Dorsal valve*; j, *cardinal process or boss*; t', *dental sockets*; p, *hinge-plate*; s, *septum*; c, *crura of the loop*; l, *reflected portion of loop*; m, *quadruple adductor impressions.*

f. 7, *Ventral valve*; f, *foramen*; d, *deltidium*; t, *teeth*; a, *adductor-impression*; r, *cardinal muscular impressions*; p, *pedicle muscles*; x, *accessory cardinal muscles*; v, *vent*; z, *attachment of the peduncle-sheath* (capsularis, ~~Owen~~).

[1] Naturforscher, i, 2d part, p. 86, tab. iii, figs. 1, 6.

[2] A Monograph of English Permian Fossils, p. 145, 1849.

a central mesial septum, which extends more or less into the interior of the shell. Structure punctated.

Obs. The animal has been admirably described and illustrated by Professor Owen in the first chapter of this Introduction; we need therefore only add, that the section was first proposed by Professor King, who at the same time represented the muscular system which he had described in 1846. As a section of *Terebratula*, I now believe the term *Waldheimia* may be advantageously preserved, especially as the number of species possessing a long loop is almost as great as that with a short one.

Geol. range.—The exact period at which *Terebratulæ* with long loops first appeared is as yet unascertained; the interior of many Palæozoic species not having been examined, some of which may possibly prove to belong to the section under consideration. *Waldheimias* were, however, certainly represented from the Trias up to the present period.

Examples: W. flavescens, Lamk., sp.; *lenticularis*, Desh., sp.; *californica*, Koch., sp.; *longa*, Roemer, sp.; *digona*, Sow., sp.; *lagenalis*, Schl., sp.; *numismalis*, Lam., sp.; *cornuta*, Sow., sp.; *resupinata*, Sow., sp.; *Waterhousii*, Dav., sp.; *Grayii*, Dav., sp.; *cardium*, Lamk., sp.; *Moorei*, Dav., sp.; *cranium*,[1] &c.

Genus—Terebratella, *D'Orbigny*, 1847.[2]

Type—T. dorsata, *Lamarck*, sp. Chilensis, *Brod.*, sp. Int., Pl. VI, figs. 11—14.

Anomia and Terebratula, of Authors.
Terebratella, *D'Orbigny*.[3]
Rhynchora (costata)? *Dalman*.

Shell elongated or transverse, variable in shape: both valves regularly and unequally convex or interrupted by a longitudinal depression in the smaller valve. Beak truncated by an oblique foramen of a circular or oval form, and partly margined by a deltidium in two pieces, at times disunited above the umbo: beak ridges more or less defined, and in some cases leaving between them and the hinge line a flat or concave cardinal area: external surface smooth or variously punctated. Hinge articulating by the means of teeth in the larger, and sockets in the smaller valve. In the interior of the dorsal valve, under the cardinal process and hinge plate, a more or less elevated medio-longitudinal crest or septum extends to about half the length of the valve: the loop is elongated and doubly attached, first to the hinge plate, and afterwards to the mesial septum, by processes given off at right angles near the centre of the valve, the remaining portion

Fig. 8.

T. Chilensis.

[1] In part i, pl. i, fig. 8 *d*, I did not give sufficient development to the loop, which in this species is two-thirds as long as the shell.

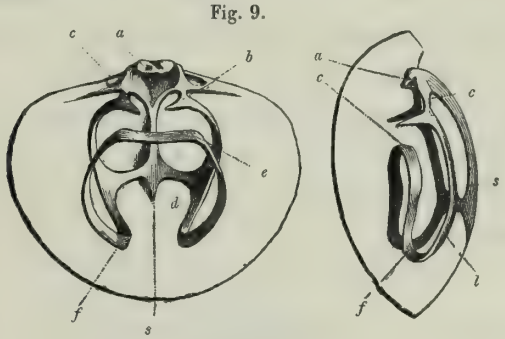
[2] Considérations Zool. et Geol. sur les Brachiopodes.—Comptes rendus de l'Académie des Sciences Paris, 1847.—Annals des Sciences, vol. viii, 1847.—Paléont. Franç. Ter. Crétacés, vol. iv, p. 110, 1847.

[3] Professor M'Coy's genus *Delthyridea* may have been intended for this section; but on referring to

soon after becoming reflected. The double impressions of the adductor are seen on either side near the mesial plate.

Obs. The animal has been ably described by Professor Owen, and the peculiar arrangement and double attachment of the loop had been observed, and more or less accurately figured, by several early naturalists, such as Grünther,[1] Davila,[2] Favanne,[3] Martini, Chemnitz,[4] Parkinson,[5] Fischer de Walderm,[6] and others; but it was only in 1835[7] that the apophysary system and animal were correctly represented. The form of the loop, as well as the development of the mesial septum, varies in different species of *Terebratella*, as may be seen in the annexed woodcuts.

Fig. 9.



T. dorsata, Lamk.

Fig. 10.

T. Evansii, Dav.

Geol. range.—Terebratella is not positively known in the Oolitic period, but the genus is represented during the cretaceous epoch, and still continues to abound in our present seas, where from ten to twelve species have been obtained.[8]

Examples: T. menardi, Lam., sp.; *pectita*, Sow., sp.; *carantonensis*, D'Orb.; *canaliculata*, Roemer, sp.; *dorsata*, Lam., sp.; *flexuosa*, King, sp.; *chilensis*, Brod., sp.; *coreanica*, Adam and Reeves, sp.; *Bouchardii*, Dav.; *rubicunda*, Sow., sp.; *zelandica*, Desh., sp.; *Evansii*, Dav.; *Sowerbii*, King, sp.; *crenulata*, Sow., sp.; &c.

the 'Synopsis of Carb. Foss. of Ireland,' p. 130, 1844, all I find there stated, is "*Delthyridea*, M'Coy, fig. 27), *or those species which have a long hinge line, and a distinct cardinal area (as in the Delthyridæ or Spirifers), the deltidium fissured in the middle, all the species are largely plaited.*" No example is mentioned, nor is the figure sufficiently illustrative to justify the author's claim to priority over M. d'Orbigny, who clearly defined his genus in 1847.

[1] Naturforscher, 1774.

[2] Cat. Syst., pl. xx, 1767.

[3] La Conchyliologie, &c., pl. xli, fig. 13, 1780.

[4] Systematische Conchylien, pl. lxxviii, fig. 711, 1785.

[5] Organic Remains of a former World, tab. xvi, fig. 7, 1811.

[6] Notice sur le Système Apoph. des Ter., pl. i, fig. 34, 1829.

[7] Owen; Trans. of the Zool. Soc., vol. i, 2d part, pl. xxii, p. 141, 1835.

[8] For a list of the recent species, see Dav., 'Ann. and Mag. of Nat. Hist.,' May, 1852.

? *Section A.* Trigonosemus. *Kœnig*, 1825.[1]

Type—T. elegans, *Kœnig*. Int., Pl. VI, figs. 15, 16.

Terebratula (part), of Authors.
Fissurirostra, *D'Orbigny*.
Delthyridea, *M'Coy*.

Shell inequivalve, oval, transverse or elongated: dental valve always convex, smaller one moderately so, flat or longitudinally depressed: beak produced, recurved and truncated by a small foramen originating at the summit of the beak and extending on the opposite side to the area. This last is large, margined and carinated exteriorly; the deltidium occupying less than a third of the surface, a small portion only edging the foramen; external surface striated or variously costated: hinge articulating by the means of teeth and sockets: between the socket ridges a remarkably large and produced cardinal process or boss fills a cavity in the beak of the larger valve; the loop is doubly attached; first near the base of the socket ridges and afterwards to a short mesial septum before becoming reflected: the adductor muscular impressions are deeply indented on either side close to the base of the septum.

Obs. The arrangements of the loop are very similar to those of *Terebratella*: the greatest difference resting in the form of the cardinal process, area, and position of the foramen. This sub-section has in reality very little importance, and cannot I think claim a generic rank.

Geol. range.—Hitherto no species has been observed out of the cretaceous period.

Examples: T. elegans, Kœnig; *pulchellus*, Nils., sp.; *incertus*, Dav.; *pectiniformis*, Buch, sp.; &c.

? *Section B.* Terebrirostra, *D'Orb.*, 1847.[2]

Type—T. lyra, *Sow.* Int., Pl. VI, figs. 17, 18.

Terebratula (part), of the generality of Authors.
Trigonosemus (part), *Koenig*.
Terebrirostra, *D'Orb.*, *De Ryckholt*, &c.
Waldheimia (part), *Gray* (not *King*).

Animal unknown. *Shell* more or less oval, inequivalve; beak considerably elongated, almost straight, with a false area and narrow deltidium: the extremity of the beak is truncated by a circular foramen, partly margined by a deltidium; valves articulating by the means of teeth and sockets; internal arrangements of the calcified supports of the arms

[1] Icones Fossilium Sectiles, 1825.

[2] Cons. Zool. et Géol. sur les Brach.—Comptes rendu de l'Acad. des Sciences, 1847; and Paléont. Franç. Ter. Cretacés, vol. iv, p. 126, 1847.

unknown; a mesial septum exists in the interior of smaller valve; cardinal process large and produced; external surface plaited.

Obs. It is still very uncertain whether this sub-section should be retained, or placed under *Waldheimia* or *Terebratella*, from the mode of attachment of its loop not having been as yet ascertained: the elongation of the beak could not alone constitute a character of generic importance. M. d'Orbigny supposes that the loop was doubly attached, while Dr. Gray seems to be of a different opinion, since he places the shell in question with *Waldheimia*.[1] It will therefore be very desirable to examine the interior of *T. lyra*, which will alone decide whether the section should be admitted or cancelled.

Geol. range.—The shells placed by authors into this small section seem, in the present state of our knowledge, confined to the cretaceous period.

Examples: T. lyra, Sow., sp.; *Bargesana*, D'Orb.; *neocomiensis*, D'Orb.; &c.

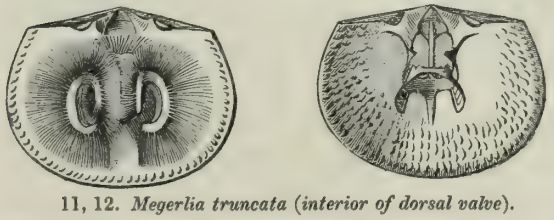
Section C. Megerlia, *King*, 1849.[2]

Type—M. truncata, *Gmel.* sp., 1152. Int., Pl. VI, figs. 26, 27.

Anomia (part), *Linnæus, Pallas*, &c.
Terebratula (part), of the generality of Authors.
Orthis, *Michelotti*,[3] *Philippi*,[4] (not orthis, *Dalman.*)
Terebratella (part), *D'Orbigny.*
Megerlia, *King, Gray*, &c.
Megathyris (oblita), *D'Orbig.*
Kingena, *Dav.* (part).

Shell inequivalve, suborbicular, transverse or longitudinally oval; beak short and truncated by a circular foramen; deltidium small; beak ridges well defined; external surface smooth, spinulose, or covered by fine radiating striæ; shell structure largely punctated; hinge line sometimes long and straight, with the articulating teeth and sockets widely separate. In the interior of the *socket* or *dorsal* valve a slightly elevated medio-longitudinal septum proceeds from under the cardinal process or boss, to less than half the length of the valve; the loop is three times attached, first to the base of the socket ridges, afterwards, by a horizontal process, to near the extremity of the septum, and

Fig. 11. Fig. 12.



11, 12. *Megerlia truncata (interior of dorsal valve).*

[1] A Catalogue of the Brachiopoda in the British Museum, 1853.

[2] A Monograph of English Permian Fossils, p. 145, 1849.

[3] Desc. des Foss. des Terrains Miocènes de l'Italie, sup., p. 78, 1847. The *Orthis oblita*, Mich., is only a synonym of the *M. truncata*, Gmel. sp.

[4] Enumeration Molluscorum Siciliæ, vol. ii, 1844.

again by two additional processes, departing from the reflected portion of the loop to the central septum. The cirrated arms are large, their fringes extending to near the border of the shell. On either side of the mesial septum are seen the double scars produced by the adductors.

Obs. Prof. King proposed to distinguish those species possessing a triply attached loop from *Terebratula* and *Terebratella*, by the name of *Megerlia;* but after a minute examination of the three or four species at present known, and which seem to vary from one another to some extent in the details of their loop, it will be preferable for the present to admit *Megerlia* simply as a section of *Terebratella*. The *M. truncata* has been by some authors placed in the genus *Orthis*, but it in no way possesses the characters of Dalman's genus. The interior of the valves, especially in the last-named species, are covered with spinulose asperities which radiate from the base of the hinge line to the margin, a character likewise observable in some species of *Productus*.

Geol. range.—In the present state of our knowledge the first species appeared during the cretaceous period, and continued under different forms up to the present day.

Examples: *M. truncata*, Gmel.; *M. lima*, Def.; *pulchella*, Sow., sp.

Genus KRAUSSIA, *Davidson*, 1852.[1]

Type—K. RUBRA, *Pallas*, sp.[2] Int., Pl. VI, figs. 28, 29.

ANOMIA, *Chemnitz, Gmelin*, &c.
TEREBRATULA (part), of the generality of Authors.

Shell subcircular, with a nearly straight hinge line; beak truncated; foramen large, round; deltidial plates small, not united; beak ridges well defined, leaving a flat false area between them and the hinge margin; in most species a longitudinal depression exists in the smaller valve: external surface smooth or variously plaited, structure punctated: the dorsal pedicle muscles produce two wide eye-shaped impressions close to the hinge, and between the inner walls of the socket ridges, a small slightly elevated mesial ridge extends to about half the length of the valve, at the extremity of which arise two small forked diverging lamellæ expanded at their extremity. The cirrated arms are unusually small, their fringes not extending to more than half-way towards the border of the shell; in the first part of their course from the mouth forward, the cirri are few or wanting: the whole brachial apparatus is supported by the small forked process above described, no other part of the apophysary system being calcified: cardinal process or boss, small.

Fig. 13. Fig, 14.

13. *Kraussia rubra* (*dorsal valve*).
14. *Kraussia Lamarckiana* (animal).

[1] Annals and Mag. of Nat. Hist., vol. ix, 2d series, p. 369.
[2] Mis. Zool., tab. xiv, figs. 2, 11. 1766.

Obs. The animal of this small genus or sub-genus (examined in two species), differs from *Megerlia* in the relative small size of the cirrated arms.

Geol. range.—Hitherto only known in the recent state.

Examples: *K. rubra*, Pallas, sp.; *K. cognata*, Chemnitz, sp.; *K. pisum*, Lamarck, sp.; *K. Lamarckiana*, Dav.; *K. Deshayesii*, Dav.[1]

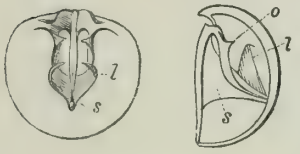
Genus—Magas, *Sowerby*, 1818.[2]

Type—Magas pumilus, *Sow.* Int., Pl. VI, figs. 19, 21.

Terebratula (part), *Lamarck, V. Buch, Deshayes*, &c.
Magas, of the generality of Naturalists.
Orthis (Millepunctata), *De Koninck*, sp. (not Orthis, *Dalman.*)

Animal unknown; *shell* small, inequivalve, more or less regularly oval; beak truncated by a foramen extending to the umbo of the smaller valve; surface smooth or slightly striated; shell structure largely punctated; apophysary system in the *dorsal* or *socket valve* composed of an elevated longitudinal septum reaching from one valve to the other, and to which are affixed two pair of calcareous lamellæ; the lower ones are riband-shaped, attached first to the hinge-plate, they afterwards proceed by a gentle curve to near the anterior portion of the septum, to the sides of which they are affixed; the second pair originate on either side of the upper edge of the septum, extending in the form of two triangular anchor-shaped lamellæ.

Fig. 15. Fig. 16.



Magas pumila.
15. *Interior of Dorsal Valve.*
16. *Section of both Valves.*

Obs. Having fully described this genus in Part II, p. 19, it will not be necessary to add any other observations.

Geol. range.—Hitherto only known in the cretaceous period.

Examples: *Magas pumila*, Sow.; *M. orthiformis*, D'Archiac, sp.

Genus—Bouchardia, *Davidson*, 1849.[3]

Type—B. tulipa, *Blainv.* sp.=(rosea, *Mawe*, sp.) Int., Pl. VI, figs. 22, 25.

Terebratula (part), of Authors.

Shell of an elongated oval shape; valves thick and almost equally convex; beak nearly straight and truncated by a small circular foramen; no true area or deltidium; external

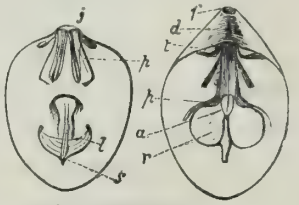
[1] The last two species are described by myself, in the 'Zool. Proc.,' for 1852.

[2] Min. Con., vol. ii, p. 40, tab. 119, figs. 1—5. 1818.—See likewise Bouchard and Davidson 'Bull. de la Soc. Géol. de France,' vol. v, 2d ser., p. 139, 1848.

[3] Bulletin de la Soc. Géol. de France, vol. vii, 2d ser., p. 62, pl. i, 1849. [4] Dic. Sc. Nat.

surface smooth; structure punctated. Valves articulating by the means of teeth and sockets. In the interior of the smaller or dorsal valve the socket ridges are largely developed, extending to nearly a third of the length of the valve, and fitting into corresponding grooves in the dental valve; the hinge plate or platform is large and massive, filling up the space between the socket ridges; and from the extremity of the umbonal beak originates the cardinal process or boss, which assumes the shape of two deviating elongated crests, grooved along their upper surface, and probably serving as an attachment to the cardinal muscles; pedicle scars are visible on the outer sides of these; at the base of the platform above described a short mesial septum gradually arises, to the upper edge of which is affixed an anchor-like pair of lamellæ, and close to the base of the septum was attached the adductor muscle. In the *dental valve* a mesial ridge separates the large cardinal muscular scars placed on either side, and towards the centre of the valve a small ovate impression indicates the place of the adductor. The ventral pedicle-muscles occupy a deep groove, which extends from the last-named scar to the extremity of the foramen, which is excavated in the substance of the beak.

Fig. 17. Fig. 18.



Bouchardia tulipa.

17. *Interior of dorsal valve*; j, *cardinal process*; l, *loop*; p, *hinge plate*; s, *septum*.

18. *Interior of ventral valve*; f, *foramen*; t, *teeth*; a, *adductor*; p, *pedicle*; r, *cardinal muscular scars*.

Obs. The remarkable organisation of this little genus is so different from that observable in the rest of the *Terebratulidæ* that I could not refrain applying to it a separate denomination; unfortunately the animal has not yet been examined, so that little can be said of the soft parts or arms, but the *cardinal process* presents a very unusual shape and character, and the whole internal details have their peculiarities.

Geol. range.—Hitherto only known in the recent state.

Example: Bouchardia tulipa, Blainv., sp.=(*rosea*, Mawe, sp.)

Genus—Morrisia, *Dav.*, 1852.[1]

Type—M. anomioides, *Scacchi*, sp. (=T. depressa, *Forbes.*) Int., Pl. VI, figs. 30, 31.

Orthis, *Scacchi* and *Philippi.*[2]
Terebratula, *Forbes.*[3]

Shell minute, circular, depressed; foramen large, round, encroaching equally on both valves; larger or dental valve with a small straight hinge area: deltidium plates minute, widely separated; valves articulating by the means of teeth and sockets; smaller or socket valve deeply notched at the umbo; apophysary system consisting of two branches, originating at the base of the dental sockets, and united to a small elevated process arising from the centre of the valve.

[1] Annals and Mag. of Nat. Hist., vol. ix, 2d series, p. 361, 1852; Proc. of the Zool. Soc., 1852.

[2] Enumeratior Moluscorum Sicilie, vol. ii, pl. xviii, fig. 9, 1844.

[3] Report of the Mollusca of the Ægean Sea, 1843.

Fig. 19.

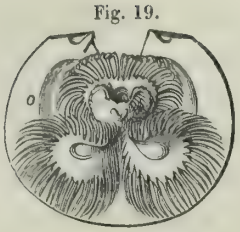
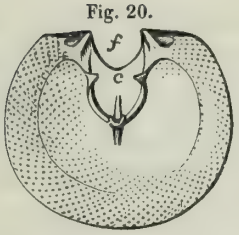


Fig. 20.



Morrisia anomioides (Scacchi, sp.)

19. *Interior of Dorsal Valve with the Animal.*
20. c, *oral processes;* f, *foramen.*

Animal furnished with two subspiral or *sigmoid* arms fringed with comparatively large cirri; these arms originate beside the mouth (as shown in the figure) supported by the crural processes, and after passing forwards and converging in front of the mouth, they again turn outwards, each having the shape of the letter S: external surface smooth and largely punctated.

Obs. The remarkable arrangement of the oral processes, large foramen, encroaching equally on both valves, and form of the apophysary system, seems to me quite sufficient to distinguish this genus or *sub-section* from the other genera in the family of *Terebratulidæ.* The type was considered by Scacchi and Philippi to belong to Dalman's genus *orthis*, of which, however, it possesses *none* of the characters.

Geol. range.—I am inclined to believe that this little genus existed in the cretaceous period, possessing several examples of a small shell from the chalk of Gravesend, which so closely resembles the recent type that I can hardly distinguish them even specifically.

Example: M. anomioides, Scacchi, sp. (*recent.*)

Genus—Argiope, *Deslongchamps*, 1842.[1]

Type—A. decollata, *Chem.*, sp., 1785. Int., Pl. VI, figs. 32, 34.

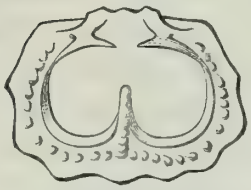
Anomia and Terebratula, in part of Authors.
Orthis, of *Michelotti, Philippi, Hagenow, &c., but not* Orthis, *Dalman.*
Mégathyris, *D'Orbigny*, 1847.

Shell semi-orbicular, quadrate or transversely oval; valves unequally convex, smooth or variously costated; ventral or dental valve the deepest, beak produced, with a depressed triangular area; foramen large, completed by the umbo of smaller valve; hinge line straight; valves articulating by means of teeth and sockets. Interior of smaller valve furnished with a central septum, and sometimes with one or more lateral septa radiating from beneath the cardinal muscular prominence, and terminating at some distance from the margin in elevated processes; apophysary system consisting of a distinct loop, originating at the base of the dental sockets and folded into two or more lobes occupying the interspaces of the radiating septa to which they adhere on their inner sides; the labial processes or arms originate on the sides of the mouth, and diverge right and left parallel with the margin of the shell, but at some little distance from it; when they arrive at the raised septa they turn inwards, forming one or more lobes on each side of the

[1] Mémoirs de la Soc. Linn. de Normandie, vol. vii, p. 9, 1842.

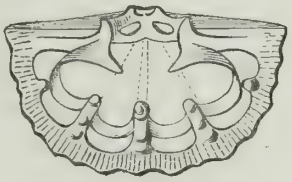
middle line, but on reaching the central septum, they become perhaps free at their extremities. The mantle adheres closely to the shell and is not seen except as a part of it.

Fig. 21.



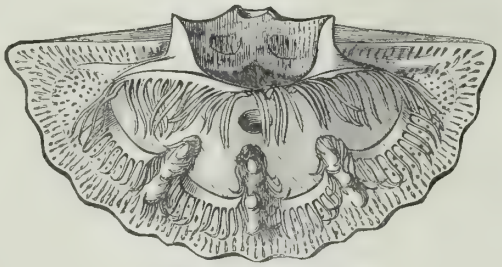
Argiope Neapolitana

Fig. 22.



Argiope decollata.

Fig. 23.



A. decollata, with the animal.

Obs. Having described this Genus in part 1, p. 8, and in part 2, p. 16, it will not be necessary to add any further details.

Geol. range.—The genus in the present state of our knowledge seems confined to the cretaceous, tertiary, and recent periods.

Examples: A. decemcostata, Rœmer, sp.; *A. hirundo*, Hag., sp.; *A. decollata*, Chem., sp.; *A. cuneata*, Risso, sp.; *A. Neapolitana*, Scacchi, sp.; *A. cistellula*, S. Wood, sp.; &c.

Sub-Family—STRINGOCEPHALIDÆ.

Antmal unknown, attached during the greatest part of its existence by means of a muscular peduncle: labial appendages supported by a largely developed calcified process or loop: a mesial septum: small in the dorsal, large in the ventral valve. Cardinal process extending to the ventral septum: shell structure widely punctated.

Obs. The peculiar assemblage of remarkable characters possessed by *Stringocephalus*, has rendered the exact place the section should occupy somewhat difficult to determine. The presence of a loop and punctated structure connects the genus with the *Terebratulidæ*, but it cannot be properly admitted into that family, on account of its acute beak, position of the foramen, deltidium and largely developed septa, which last-named characters belong more particularly to the *Rhynchonellidæ*; it will therefore be preferable, at least for the present, to follow Professor King in keeping the section distinct, by placing it in a small sub-family, close to the *Terebratulidæ*.

Genus—Stringocephalus, *Defrance*, 1827.[1]

Type—S. Burtini, *Def.* Int., Pl. VII, figs. 95—98.

Terebratula (part), *V. Buch*, &c.

Strigocephalus, *Def.*, and of the generality of Authors.

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[1] Dic. d'Hist. Nat., vol. li, p. 102, pl. lxxv, fig. 1, 1*a*, 1827.

[2] Most authors write the name *Strigocephalus*, but the proper spelling is *Stringocephalus*.

Shell transversely or longitudinally oval; valves unequally convex; beak acute, entire, and slightly incurved; area defined and divided in young individuals by a large triangular fissure, which is afterwards reduced to an oval foramen, entirely surrounded by a deltidium, and finally closed in some adult individuals; external surface smooth; valves articulating by the means of a large tooth situated on either side of the deltidium, close to the hinge line, and fitting into corresponding sockets in the smaller valve. In the interior of the ventral valve a large mesial longitudinal septum extends to a short distance of the frontal margin: this plate is thick at its origin and base, but gradually decreases in width while increasing in depth, as it recedes from near the extremity of the beak. In the smaller or dorsal valve, a massive curved cardinal process stretches to the opposite valve where it clasps the ventral mesial septum with its bifurcated extremity; near the base of this process in the dorsal valve a longitudinal septum arises (smaller than that of the ventral valve), and which divides the quadruple impressions of the adductor muscle; the socket walls are very much expanded, forming prominent hinge-plates curving inwards on each side of the cardinal process. The lower portion of the hinge-plate supports the crura of the loop in the shape of two flattened stems or lamellæ, which after proceeding with a slight upward curve to near the extremity of the septum, are suddenly reflected, and again approach the sockets before sweeping sub-marginally round in the shape of a large wide loop, from the inner edge of which a number of smaller lamellæ branch off and converge.

Fig. 24.

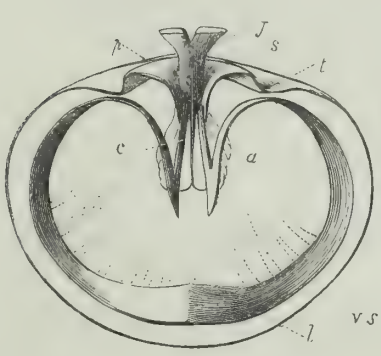
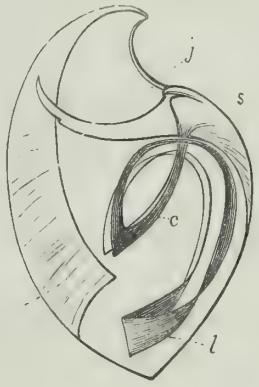


Fig. 25.



Stringocephalus Burtini.[1]

24. *Interior of the dorsal valve, partly restored, from a specimen in the Collection of Professor King.*

25. *A section of the valves;* j, *cardinal process or boss;* s, *septum in dorsal valve;* vs, *septum in ventral valve;* t, *sockets;* c, *crura of the loop;* l, *loop;* a, *adductor.*

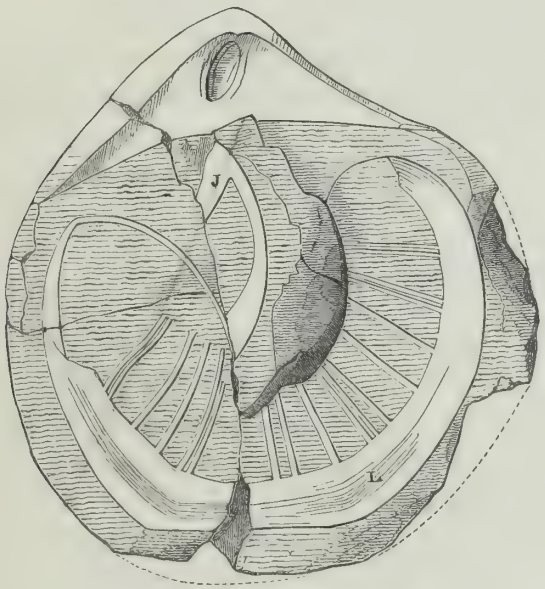
Obs. Great efforts have repeatedly been made to obtain a complete knowledge of the internal characters of this most remarkable shell, so solidly constructed, and so dissimilar from what we observe in the other sections of the class.[2] Some of the internal arrangements have been known for many years, since we find an attempt to illustrate the large

[1] I feel greatly indebted to Professor King for the communication of the original specimen from which his diagram ('English Permian Fossils,' pl. xix, fig. 1, 1849), had been drawn; figures 24 and 25 restored from the Professor's specimen, but want the branch lamellæ discovered by M. Suess. I am likewise greatly indebted to MM. de Koninck, Beyrich, Bouchard, and Suess for the communication of specimens and sketches of their best examples of the genus.

[2] Baron von Buch describes at great length the external appearance of this shell, but makes no allusions to any of its internal characters, he places it, with some doubts, among the *Terebratulæ*.

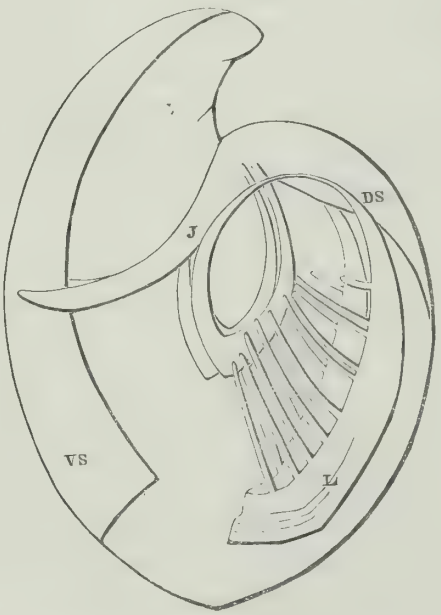
forked cardinal process in De Blainville's 'Conchyliologie et Malacologie;' but it is to Professor King and M. Suess that science is indebted for the knowledge we now possess of the calcified supports of the labial appendages. The first-named author published a restored figure of a loop, which he describes as a single piece, *having a tolerably close agreement with that of certain Terebratulæ*, but M. Suess subsequently discovered that Professor King's drawing, although correct, was incomplete, since a number of lamellæ, sometimes single, at other times bifurcated, branched off from the inner edge of the loop, as represented in the annexed woodcuts;[1] and it still remains to be known with certainty whether

Fig. 26.



Unrestored Figure.

Fig. 27.



Profile (partly restored).

J, *Cardinal process;* L, *loop;* DS. *dorsal septum;* VS, *ventral septum.*

[1] Sketches of the diagrams here introduced were kindly forwarded by my Viennese friend, and are the result of his continued researches on the genus:—

Fig. (26) is an *unrestored* representation by M. Suess, of his best example, and exhibits the exact extent of our knowledge on the shape and character of the internal skeleton or loop.

Fig. (27) is a restored profile of both valves. M. Suess accompanies this diagram with a few observations which I have much pleasure in reproducing. "The profile view which has been added, although, perhaps incomplete, is correct, and contains all I know on the subject. The great lateral expansions of the loop (which may not exactly be termed crural plates, since the crura are fixed beneath them), have been omitted, because they would cover the upper part of the loop, the rim following exactly the contour of the shell, so that the *cirri* might surround the whole circumference of the shell, with the single exception of the cardinal region. A comparison of the loop and its branches with the corresponding process of the one-lobed *Argiope* (bearing one septum), has shown me much analogy between those forms: the flat, broad, widely developed loop is hardly recurved in front, the deflected portion so considerable in most *Terebratulæ* is barely indicated in *Stringocephalus* by a straightened frontal piece, similar to that in

Obs. We are indebted to Defrance for the institution of this excellent genus,[1] which has received the sanction of all naturalists; but perhaps no section contains an assemblage of shells more variable in their internal arrangements: these differences are chiefly observable in the interior of the smaller valve. In some species, such as the *Th. Moorei, Deslongchampsii, Wetherellii, rusticum, hippocrepis, sinuatum*, &c., the granulated margin on reaching the front extends inwards to a variable distance, assuming the shape of a narrow mesial ridge or expanded concave and sinuated dissepiment; in other forms, such as the *Th. radiatum, recurvirostris, Mediterraneum*, &c. the mesial dissepiment is irregular in shape, giving off at variable distances unequal lateral branches; while in some cases, *Th. digitatum, hieroglyphicum, rugosum*, (D'Orb.) &c., numerous dissepiments, variable in form and dimensions, arise from all round the margin, into which the apophysary ridge extends and follows the curves of the digitated grooves. Great dissimilarity likewise exists in the extent of the attached surface of the dental valve, which has a great influence on the regularity or shape of the species and valve; but however great or small the affixed portion is, it invariably originates from the extremity of the beak.[2]

The generality of species have both their valves convex, or the smaller one almost flat; but in *Thecidia Leptænoides*, (Deslong.) not only is the socket valve concave, but it is much smaller than the other, which protrudes considerably beyond the margin of the ventral one.

Geol. Range.—This genus, so far as we know, first appeared in the Salt-marls of St. Cassian.[3] In the Lias, the species was both numerous and large, from that epoch the genus continued uninterruptedly to the present period, and the section is still represented by a single species.

Examples: *Th. Moorei*, Dav.; *Mayalis, Leptænoides, sinuatum, Koninckii*, E. Deslong.;[4]

[1] Dictionnaire des Sciences Nat., vol. liii, 1828.

[2] M. D'Orbigny states in the fourth volume of his 'Paléont. Franç. Ter. Crétacés,' p. 151, that on examining the beak of some of the Terebratuliform species, he observed the remains of a foramen whence a pedicle must have issued; and in my second part, p. 13, I reproduced that view, but which I now consider to be very improbable, and feel much more disposed to believe that *Thecidium* was in all cases, in the young age, fixed by the substance of its beak to sub-marine bottoms.

[3] Klipstein describes and figures, in his 'Beitrage zur Geol. Kenntness der Astlichen Alpen,' plate xv, fig. 19, a species which he terms *Spirifer bidorsatus*, but on an examination of the original figured example now in the British Museum, Mr. Woodward pointed out to me that it most probably was a *Thecidium* approaching in character to the *Leptænoides*, Desl. It is certainly *not* a spirifer, and exhibits undeniable traces of its attachment by a portion of its ventral valve.

[4] In a very interesting and valuable paper on the *Leptænas* and *Thecidia* lately discovered in the Oolitic formations of Normandy, published by M. Eugene Deslongchamps, in the ninth volume of the 'Mémoires de la Soc. Lin. de Normandie (1853),' the learned author adds several new and interesting details relative to *Thecidium*, dividing the genus into two groups, from the presence or total absence of what we have termed "*the apophysary ridge*," and I cannot do better than to add an extract in the author's own words—

"D'après l'inspection des intérieurs des différentes espèces de Thécidées de tous les terrains, je pense qu'on peut diviser facilement ce genre en deux sections. Si l'on regarde avec attention les intérieurs de deux espèces qui au premier coup-d'œil, semblent être assez voisines, la *Thecidea Mayalis* (espèce

triangularis, D'Orb.; *Davidsoni*, Buv.; *Bouchardi*, Dav.; *rusticum*, Moore; *Deslongchampsii*, Dav.; *rugosum*, D'Orb.; *Wetherellii*, Morris; *recurvirostris*, Def.; *tetragonum*, Rœmer; *Hieroglyphicum*, Def.; *hippocrepis*, Goldf.; *Mediterraneum*, Risso; &c.

Family—SPIRIFERIDÆ.

Animal free, or rarely attached by a muscular peduncle; oral appendages largely developed, and entirely supported by a thin shelly spirally rolled lamella; shell structure either punctated or unpunctated.

Obs. We have provisionally admitted five genera and two sub-sections; but it is probable that when the characters of many of the species are better known, the family will require further modifications.

Genus—Spirifer, *Sowerby*, 1815.

Type—Sp. striatus, *Martin*, sp. Int., Pl. VI, figs. 48—59.

Anomia, *Linn.* (part), *Martin*, &c.
Terebratulites, *Schloth.* (part).
Terebratula, *Lamarck* (part).
Choristites, *Fischer*, 1825.
Trigonotreta, *Kœnig*, 1825; *King*, 1849.
Delthyris, *Dalman*, 1827; *V. Buch*, &c.
Spirifer, of the generality of Authors.
Martinia, Spirifera, Brachythyris, reticularia (part), *M'Coy*.

Liasique) et la *Th. digitata* (espèce Crétacée), on verra dans la première un appareil unique naissant du bord frontal de la coquille, tandis que dans la seconde il y a, outre ce même appareil que j'appellerai *ascendant* un autre appareil suivant à peu près le contour du premier, mais dans une direction contraire; cet autre appareil, que j'appellerai *descendant* (*our apophysary ridge*), nait d'une bride transversale située au tiers à peu près de la coquille du côté de l'apophyse dentaire. Le double système se remarque surtout dans les espèces Crétacées et dans l'espèce vivante.

"Je prendrai pour type de Thécidée à appareil double la *Th. digitata*, où il semble être le plus marqué et pour type de *Thécidée* à appareil simple les *Th. Mayalis, leptænoides, rustica*, &c. Les Thécidées à appareil simple semblent dominer dans le lias, tandis que c'est à la première section, ou à appareil double, qu'il faudrait rapporter les espèces crétacées. Les espèces jurassiques, que je rapporte à cette dernière section ne présentent même qu'incomplètement le système descendant; il y est représenté seulement par une petite bride demi-circulaire située de chaque côté de la côté centrale, comme on peut le voir dans la *Th. Deslongchampsii*, je ne pense pas qu'on puisse regarder les grosses granulations des *Th. Moorei, sinuata*, &c., comme suffisantes pour caractériser l'appareil descendant: je considère donc ces Thécidées comme des espèces à appareil simple."

Thus, according to M. Deslongchamps, in the first group, *with an apophysary ridge*, would be placed *Th. digitatum, radiatum, Mediterraneum, Wetherellii, recurvirostris, papillatum, rugosum, hieroglyphicum, hippocrepis, tetragonum*, &c. &c.

In the second group, where *no apophysary ridge* can be traced, the author places *Th. leptænoides, Bouchardii, Mayalis, sub-Mayalis, Perierii, Koninckii, rusticum, Moorei, sinuatum*, &c.; he likewise adds some details relative to the "*bridge-shaped process*."

Animal unknown; shell somewhat trigonal, transverse or elongated, inequivalve, with or without a mesial fold and sinus; hinge line shorter or longer than the width of the shell; cardinal angles obtusely rounded, or extended into wing-shaped expansions; external surface smooth, or variously costated; shell structure unpunctated; valves articulating by means of teeth and sockets; beak straight or recurved; area in ventral valve large or narrow, and nearly parallel sided, bent backwards, flat or concave, and divided by a triangular fissure, always more or less closed by a pseudo-deltidium notched in the vicinity of the cardinal edge; area in the *dorsal valve* narrow, often linear, and likewise divided by a wide open fissure, partly or entirely occupied by the cardinal muscular process or boss.

In the interior of the smaller valve the labial appendages were supported by calcified lamellæ, assuming the shape of two large conical spires, which nearly fill the interior of the shell; the ends of the spires are directed outwards, towards the cardinal angles; the bases of the hollow conical spires nearly meet at the hinge side, but are wide apart in front; the hinge-plate is divided into two portions, to which the crura of the spires are attached; the crura are united, at some distance from the hinge, by an oral lamella; the divisions of the hinge-plate are hollowed, perhaps for the insertion of pedicle muscles; the cardinal muscles (adductor brevis of Owen), were no doubt fixed to the cardinal process or boss, which is small, and situated in the notch of the hinge-plate; under it are seen four large elongated scars left by the adductor.[1] In the interior of the *larger valve* a short hinge tooth is situated on either side at the base of the fissure, supported by vertical shelly plates, which extend from the beak to the bottom of the valve, thus forming the fissure-walls and assuming various forms and directions in different species; they are either small, regularly diverging, or converging to diverge again, and extending to a greater or less distance into the interior of the valve; between these a great portion of the free space at the bottom of the shell is filled up by muscles, which are generally divided by a blunt longitudinal crest; the adductor commonly producing a small longitudinal and mesial oval scar, and on either side of which are situated the cardinal muscles; pedicle impressions cannot be detected in this valve.

Obs. The shells placed under this head, have been sub-divided into many sections and genera, often established upon unimportant or superficial variations, partaking more of the specific than generic character. When the interior of a larger number of species shall have been carefully examined, it is possible that the genus may require to be sub-divided into a few minor sub-sections, but I do not consider our present knowledge of the species sufficient to warrant the adoption of any other sub-sections than, perhaps, those of *Spiriferina*, D'Orb., and *Cyrtia*, Dalman; and even to these, I do not attach great value.

[1] On a remarkable cast of *Spirifer alatus*, figured by Professor King, in his work on 'English Permian Fossils,' the quadruple adductor scars appear to be situated in pairs one above the other, in a somewhat different manner to what we observe in the generality of Spirifers, as, for example, *Sp. striatus*, *Lonsdalii*, &c. On the same specimen, the vascular impressions are well preserved.

The *Anomites striatus* of Martin is the true type of SPIRIFER, since its remarkable spirals induced Sowerby to found the genus.[1] Dalman, in 1827 or 1828,[2] from mere caprice, altered the names of several of Sowerby's genera: for Spirifer he proposed to substitute the term *Delthyris*, which was adopted by some few, but it is now almost entirely abandoned. Prior to Dalman, Kœnig had proposed the name *Trigonotreta*,[3] and Fischer de Waldheim that of *Choristites*,[4] for species agreeing with Sowerby's type; both are consequently synonyms. Professor M'Coy's genus *Martinia* was proposed for those species *in which the hinge line was shorter than the width of the shell, and dorsal edges of the cardinal area obtusely rounded with a smooth surface, and small spiral appendages*;[5] but the length of the hinge line is so very variable, even in specimens of the same species, that on such a character it seems very unsafe to found a genus; the species are also both smooth and plicated and the disposition of the spiral appendages does not appear to be distinguishable from that of other *Spirifers*. It will, therefore, be preferable to postpone the adoption of the section *Martinia* until some more tangible differences can be pointed out.

[1] A difference of opinion having arisen, as to the type of Sowerby's genus, it may be remarked, that in 1814 the author first called attention to the internal organisation of *An. striatus*, in a paper read before the Linn. Soc., and published in vol. xii, p. 514, of its transactions: the author likewise adds, "*I suspect* An. cuspidatus *figured since the reading of this paper as* Sp. cuspidatus '*Min. Con.*,' *tab.* 120 . . . . . *may have a similar construction within, as well as* An. subconicus *of Martin, tab.* 47." This subsequent remark published in the same year as the generic description in the 'Min. Con.,' 1815, denotes that the author looked upon *A. striatus* as the type, and not *cuspidatus*, of whose internal character he was not *quite certain*. Not being acquainted with these facts, Professor King in his 'Mon. of English Permian Fossils,' urged the adoption of *S. cuspidatus*, as the type of Sowerby's genus, and to employ the term TRIGONOTRETA, proposed by Kœnig in 1825, for shells similar to *S. striatus*; but the learned professor now abandons that view and admits *S. striatus* as the type of Sowerby's excellent genus *Spirifer*. Professor M'Coy has justly pointed out the fact above noticed, in his 'Synopsis of Carb. Foss. of Ireland,' p. 135, 1844, for when describing *Spirifer striatus*, he adds, "*This shell is very well known on the continent as the species in which Mr. Sowerby first discovered the spiral appendages.*" While publishing my report on the Lamarckian species of *Terebratula*, I was enabled to prove that *Ter. spirifera* (Lamarck) was a synonym of *An. striata* of Martin, nor does the celebrated French naturalist omit to remark in the sixth volume of his 'An. sans Vert.,' p. 257, 1819, that "*Mr. Sowerby l'a distinguée comme genre.*" The nature of the spiral processes has been much misunderstood: the celebrated author of the 'Mineral Conchology' believed them to be *cartilaginous tubes*; and, at a more recent period, Prof. M'Coy contended that they could not be the *labial arms*, and described them as "cardinal teeth," giving at the same time a woodcut, in which they are turned the wrong way in the shell. Syn. Carb. Foss. Ireland, p. 127, 1844.

[2] Petref. suecana (Proc. R. Acad. Sc., Stockholm, 1828).

[3] Icones Fossilium Sectiles (cent. prima) 1825.

[4] Notice sur le Genre *Choristites*; Moscow, 1825.

[5] Synopsis of the Carb. Lime Foss. of Ireland, p. 139, 1844. Professor M'Coy introduces a woodcut, No. 22, illustrating his idea of the proportions of the spirals, and which are stated to be *so small as only to occupy the rostral half of the shell*; and again, in another work on the 'British Pal. Foss. in the Camb. Museum,' p. 192, 1852, the same author states the spiral appendages to be *very small*, but it so happens that I have never been able to find a single specimen out of the great number of *Martinias* which have passed through my hands, exhibiting such small spirals as described by the learned author.

I cannot conclude these few remarks without mentioning how much science is indebted to the late Baron von Buch,[1] M. de Koninck,[2] De Verneuil,[3] Prof. M'Coy, and others, for their numerous investigations of the species composing this extensive genus.

Geol. range.—True *Spirifers* first made their appearance in the lower Silurian epoch, and continued to exist all through the Palæozoic formations, the last well authenticated examples being found in the Trias?

Examples: *Sp. Striatus,* Martin, sp.; *Cyrtæna,* Dal.; *Anossofi,* Vern.; *Verneuili, Archiaci,* and *Bouchardi,* Murch.; *Mosquensis,* Fischer, sp.; *Pailleti, Rojasi* and *Pellico,* de Verneuil; *alatus,* Schl.; *glaber,* Sow.; &c. &c.

Sub-section A.—Spiriferina, *D'Orbigny,* 1847.

Type—S. rostrata, *Schl.,* sp. Int., Pl. VI, fig. 60.

Spirifer (part) of the generality of Authors.
Spiriferina, *D'Orb., M'Coy,* &c.

Shell generally transverse; valves unequally convex, with or without a mesial fold; surface smooth or costated; beak straight or recurved; area commonly largely developed and interrupted by a pseudo-deltidium, notched in the vicinity of the cardinal edge; shell structure punctated; surface spinose; hinge line commonly shorter than the width of the shell; valves articulating by means of a strong cardinal tooth situated on each side at the base of the fissure, supported by strong largely developed vertical shelly plates, and corresponding with sockets in the interior of the smaller valve; the space intervening between the dental plates in the interior of the ventral valve is occupied by the cardinal muscles, which are divided by an elevated mesial septum, wide and thick at its base, but gradually tapering into the shape of an acute blade, to the sides of which the adductor was, no doubt, fixed; in the interior of the dorsal valve the shelly lamellæ destined to support the cirrated arms assume the form of two large spiral horizontal cones.[4]

Obs. Besides the important difference in shell structure, a largely developed mesial septum exists in the punctated species, but no such plate is known to occur in the impunctate forms. It may, perhaps, therefore be preferable to follow M. d'Orbigny in adopting *Spiriferina* as a sub-section of *Spirifer,* a view already embraced by Professor M'Coy.[5]

[1] Über Delthyris, 1837; and Mém. Soc. Geol. de France, vol. iv, 2d part, 1840.

[2] Desc. des An. Foss. de la Belgique, 1842-44.

[3] Geol. of Russia and the Ural Mountains, vol. ii, 1845, &c.

[4] Some of the species belonging to this sub-section have been fully described in Part iii, under the genus *Spirifer.*

[5] It is possible, that the *Sp. heteroclyta,* Def., *Demarlii,* Bouch., *Hispanica,* D'Orb. sp., and some other Palæozoic species, which are closely punctated, should be admitted into this sub-genus in preference to *Cyrtia,* which is impunctate.

Geol. range.—The exact period at which the punctated *Spirifers* first appear is still doubtful; they are known from the Devonian epoch to the upper Lias, above which no example has been as yet recorded.

Examples: *Spiriferina rostrata*, Schl., sp.; *Tessoni*, *Deslongchampsii*, and *Munsteri*, Dav.; *oxypterus* and *signensis*, Buv.; *cristata*, Schl. sp., &c.; *Haueri* and *Emerici*, Suess.

Section B.—Cyrtia, *Dalman*, 1827.[1]

Type—C. exporrecta, *Wahl.* Int., Pl. VI, figs. 61, 62 (63 and 64?).

Spirifer, of the generality of Authors.
Cyrtia, *Dalman, D'Orbigny, M'Coy*, &c.

Shell somewhat trigonal; valves convex; hinge line nearly as long as the width of the shell, articulating by means of teeth and sockets; dental or ventral valve very deep, more or less pyramidal; beak straight, or slightly recurved; area wide and triangular; fissure entirely covered by a convex pseudo-deltidium in one piece, generally perforated extremely close to the beak by a circular foramen; sometimes this deltidium is longitudinally depressed along its centre, from the extremity of the beak to within a variable distance of the cardinal edge; at the extremity of this shallow groove is seen a small circular aperture, which up to a certain age afforded passage to pedicle muscular fibres; *the socket or dorsal valve* is very slightly convex, and is supposed to have been furnished internally with spiral cones; in the *larger valve* a mesial longitudinal septum extends from the extremity of the fissure to a short distance of the margin, and to the sides of which the dental plates converge, and are united after having formed the fissure walls.

Obs. Since the genus *Cyrtia* has been admitted by a number of Palæontologists, it may be desirable to investigate the grounds for such a conclusion. Dalman's diagnosis is unsatisfactory, and equally applicable to several species of his genus *Delthyris*: we are informed that in *Cyrtia* the shell is *inequivalve, larger valve raised into a semi-cone or half pyramid, with the hinge side vertically flat, foramen circular, hinge line straight.* —*Examples. C. exporrecta* and *trapezoidalis.*

The shells here mentioned are varieties of one species, well known in England, which must therefore be considered as the type of the section, and from it our diagnostic has been extended. It should also be remarked, that a microscopic examination by Dr. Carpenter, has proved its shell structure to be fibrous, impunctate, and similar in character to that of *Spirifer proper* (*Striatus*). The only differences at present known consist in a slight modification in the character of the deltidium, and presence of a circular perforation for the passage of a pedicle; likewise in the direction of the dental plates, and

[1] *Petrefacta suecana*, in 'Kongl. vet. Acad. Handl.,' 1827.

[2] This character is beautifully displayed in some Devonian species found in Belgium and China.

presence of a mesial septum, which may perhaps entitle those and similar species to be placed together as a small sub-section subordinate to *Spirifer*, as judiciously proposed by Professor M'Coy.[1] It now remains to be ascertained whether all the species classed under *Cyrtia* really belong to the sub-section,[2] thus, for instance, the *Sp. heteroclitus, Demarlii,* and a few others, which exteriorly appear to resemble the type of *Cyrtia,* possess entirely dissimilar *shell structure,* which Dr. Carpenter has proved to be largely punctated; and these last would, therefore, have quite as valid a claim to be separated from *Cyrtia,* as *Spiriferina* was, by its structure and plates, from *Spirifer proper.* It is therefore evident that much more will require to be known of the internal and structural character of the numerous species of *Spirifer* before the *genus* can be *properly* and *definitely* subdivided; and all we can say at present is, that a portion of the species composing the great genus SPIRIFER is punctated, while, perhaps, the greater number are not so, and it will be interesting to ascertain, by a minute investigation of the known species, how far the differences in the shell structure are accompanied by internal modifications.

Geol. range.—The exact period at which *Cyrtia* first appeared is uncertain; the types of the sub-section lived during the upper Silurian era, and the last representatives, at present known, are stated to have existed during the Trias.

Examples: C. trapezoidalis and *exporrecta,* Dalman, *Murchisoni,* De Kon.;[3] *cuspidata,* Martin, sp.; *Calceola,* Klipstein, sp.; &c.

Genus—ATHYRIS, *M'Coy,* 1852.[4]

Type—A. TUMIDA, *Dal.* or HERCULEA, *Barrande.* Int., Pl. VI, figs. 71—76.

ATRYPA (part) of *Dalman, King,* and some other Authors.
ATHYRIS (part) *M'Coy,* 1844.
TEREBRATULA, *Sow.* (part) 1815, and of the generality of Authors.
SPIRIGERA (part) *D'Orb.,* 1847.

Animal unknown; *shell* of a variable shape, circular, elongated, or transverse; valves more or less unequally convex, with or without a mesial fold and sinus; beak *apparently*

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[1] British Pal. Fossils in the Camb. Mus., 1852.

[2] In the 'Tableau du Prodrome,' vol. iii, p. 56, we perceive that M. d'Orbigny has placed under CYRTIA the following species: *C. calceola, cristata,* Schl.; *dorsata,* M'Coy; *hispanica,* D'Orb.; *laminosa, mesogonia, subconica, exporrecta, heteroclita,* and *trapezoidalis;* but we feel surprised that the author should have admitted such an assemblage, since he positively states every time he has had occasion to mention *Cyrtia,* that the shell structure was fibrous and impunctate; *S. cristata,* Schl., in particular has been known some years to belong to M. d'Orbigny's section *Spiriferina.*

[3] This species is found in Belgium, and has lately been obtained from China, by Mr. Hanbury, and presented to the British Museum.

[4] Brit. Pal. Foss., 1852.

imperforated,[1] incurved, and in general overlying the umbo of the smaller valve; no area or defined beak ridges; valves articulating by teeth and sockets; external surface commonly smooth. In the interior of *larger or ventral valve* the dental plates are fixed to, and along the sides of a longitudinal prominence or convex, arch-shaped plate, which extends to less than a third of the length of the shell, with its narrow end fitting into the extremity of the beak, and its lateral diverging edges to the bottom of the valve. In the free medio-longitudinal region, between the gradually declining base, or prolongations of the condyle plates, were situated the cardinal and adductor muscles; this last has left a small, elongated, heart-shaped scar, under and along the outer sides of which are seen the much larger oval impressions of the cardinal muscles. The interior of the *smaller or dorsal valve* is partly divided by a large, deep, longitudinal septum, which extends from the extremity of the umbo to about two-thirds of the length of the shell, supporting at its origin the hinge-plate, which is divided into two portions by a narrow gradually widening channel; to the socket ridges are affixed the spiral cones, the extremities of which are directed towards the lateral margin of the shell; on either side of the septum are seen two muscular scars formed by the adductor.

Obs. I felt greatly embarrassed as to the course advisable to pursue relative to the name *Athyris* proposed by Professor M'Coy for a few species which do not always agree with the *derivation* of the term, or with the short undetailed diagnosis then published, viz., "*nearly orbicular, small; no cardinal area or hinge line; spiral appendages very large, filling the greater part of the shell.*" The author names several examples, of which some are decidedly perforated, *T. concentrica* (De Buch); others apparently not so, while a few belong to the genus *Spirifer* of Sow.; it is true the Professor had then the erroneous belief that his first-named type *when perfect*, was imperforated, and therefore gave to his section a name implying such a condition. In 1847, M. d'Orbigny objected to the denomination, stating it to be "*in complete contradiction with the zoological characters*,"[2] and proposed as a substitute the name SPIRIGERA—*T. concentrica* of Baron de Buch, being his type. Shortly before (1835 or 1836), Professor King having received from the Eifel a specimen labelled *T. concentrica*,[3] but which was really an example of *T. scalprum*, erroneously described the Baron's species "*with condyle plates attached to a process resembling* a shoe lifter;"[4] impressed with that idea, and justly perceiving certain important differences in a Permian species (*T. pectinifera*), he proposed for this last a separate generic

[1] Although no well-defined foramen is visible in the generality of half grown or adult individuals, I have clearly traced the existence of a small circular aperture in some young examples, which no doubt became cicatrized, and dispensed with at a more advanced period of the animal's life.

[2] Paléont. Franç. Ter. Cretacés, vol. iv, p. 357, 1847.

[3] Professor King having most obligingly forwarded for my inspection his so-called *T. concentrica*, I at once recognised in it a well-known Eifel species, *T. scalprum* of Rœmer.

[4] Ann. and Mag. of Nat. Hist., vol. xviii, p. 86, 1846, in that paper Professor King ably describes the remarkable process above mentioned.

appellation, selecting for that purpose CLEIOTHYRIS of Phillips,[1] but not exactly in the sense intended by that author. It however so happens that the *true T. concentrica* and *T. pectinifera*, although different species, are essentially similarly organised, and belong to the same group, while on the other hand, Professor King's so-called *Athyris concentrica* possesses the characters of another section, of which *A. tumida* (Dal.,) or *T. Herculea* of Barrande, may serve as types. If we preserve Professor M'Coy's misnomer, *Athyris*, for *T. concentrica*, another name would be required for those species possessing the shoe-lifter process described by Professor King, but which have been united into the same group, both by M. d'Orbigny, Professor M'Coy, and others. On perusing the last-named author's recent publication,[2] I find therein a slight but *important* modification in the description of *Athyris*, viz., "*a strong mesial septum exists in the rostral portion of the entering valve; dental lamellæ are moderate; no foramen.*" Example, *A. tumida*, Dal. Such a diagnosis could in no way answer to *T. concentrica*, while, on the contrary, it quite agrees with the state of things observable in the group characterized by *A. Tumida*[3] and *Herculea*. I therefore think that it would be preferable to retain for the last-named species and similar forms with an apparently imperforate beak or closed foramen, variously disposed septa, and largely developed dental plates, the term ATHYRIS, M'Coy; and to adopt for those forms similar to *T. concentrica, pectinifera, Roissyi*, &c., the name SPIRIGERA, D'Orb., by which means the palpable misnomer of Professor M'Coy is partially got rid of, and the name *Athyris* still retained for shells more closely partaking of the author's diagnosis and intentions.[4] The species belonging to this section are easily distinguished externally from *Spirigera* by a longitudinal line, which extends along the smaller valve from the umbo to half or more of its length, and which denotes the presence of the internal

[1] A Mon. of English Permian Fossils, p. 137, 1849. Professor Phillips proposed the name *Cleiothyris* as a substitute for Dalman's *Atrypa*, but did not employ it in his work, 'Fig. and Desc. of the Pal. Fossils of Cornwall, &c.,' p. 55, 1841.

[2] British Pal. Foss. in the Camb. Mus., p. 196, 1852.

[3] It is worthy of notice that Sowerby was the first author who described and figured the exterior and spires in this species, under the name of *T. obtusa*, and which denomination seems to hold priority over that of *tumida*, given to the same species by Dalman in 1827.—See Sowerby; Some Account of the Spiral Tubes or Ligament in the Genus *Terebratula* of Lamarck, &c., read in 1815, and published in vol. xii of the 'Trans. of the Linn. Soc of London,' p. 515, pl. xii, fig. 3, 4.

[4] Before coming to the above conclusion, I submitted my views to M. Deshayes, Mr. Salter, and others, who seemed to consider that this mode of compromising the difficulty could not reasonably be objected to by the two authors principally concerned, nor by the generality of Palæontologists. I have always been of opinion, that if a name implies a radical zoological error it should be expunged, as the great object of science is to improve the nomenclature, and not to endeavour to *perpetuate an error*, even on the grounds of priority.

I must not omit to observe, that there exists a slight difference in the interior of *A. tumida* and *herculea* from the shoe-lifter process, assuming only a rudimentary state in the first species; but it seems to possess all the other *essential* characters of the genus, and I therefore agree with Professor King who proposes to place them both for the present into the same section.

septa, and also by the two diverging lines which extend from the extremity of the beak to about two-thirds of the length of the valve, indicating the presence of the large condyle plates and shoe-lifter process.[1] Professor Quenstedt forms for *Athyris* and *Spirigera* a small sub-section, which he designates by the name of TEREBRATULA SPIRIFERINA;[2] but it seems much more convenient, as well as desirable, to give to each group a distinct appellation, and to place these last in the family *Spiriferidæ*.

Geol. range. — This genus seems in our present knowledge restricted to the Palæozoic era; appearing first in the Silurian period, it is abundantly distributed in the Devonian age, but until the interior of many doubtful species has been examined, it will not be possible to point out its exact range.

Examples: A. tumida, Dal.; *Herculea*, Barr.; *pseudo-scalprum*, Barr.; *Scalprum*, Rœm.; *plebeia*, Ph., sp.; &c.

Genus—SPIRIGERA, *D'Orb.*, 1847.

Type—T. CONCENTRICA, *Buch.*, sp. Int., Pl. VI, figs. 65—70 and 78.

ATHYRIS and ACTINOCONCHUS, *M'Coy* (part).
TEREBRATULA (part) of the generality of Authors.
SPIRIGERA, *D'Orbigny*.
CLEIOTHYRIS, *King* (non *Phillips*).
RETZIA ? *King*.

Animal unknown, *shell* inequivalve and variable in shape; circular, subquadrate, elongated, transverse, globose, or depressed, with internal spires; valves articulating by teeth and sockets; beak short, more or less incurved and truncated by a small round aperture lying contiguous to the umbo of the socket valve, or separated by a deltidium in two pieces; no true area; beak-ridges more or less defined; valves convex and divided or not by a mesial fold and sinus; surface smooth, striated or variously costated, and marked by numerous concentric lines of growth, sometimes produced considerably beyond the margins of the shell in the shape of foliaceous expansions. In the interior of the *smaller* or *dorsal* valve, the hinge-plate presents four depressions or pits, which afforded attachment to pedicle muscles; and close to the extremity of the umbo, a small circular aperture, appears at times to communicate with a cylindrical tube[3] which, after

[1] Several of the species belonging to this group have been figured and described by M. Barrande, in the 'Ueber die Brachiopoden der Sil. Schichten von Bœhmen, 1847.' I am likewise indebted to M. Suess, of Vienna, for much valuable information regarding *A. herculea*, and for the loan of several of his unpublished figures.

[2] Handbuch der Petrefackunde, p. 474, 1851.

[3] The discovery of this remarkable appendage in *T. concentrica* is entirely due to M. Bouchard, of Boulogne, that distinguished author having many years ago beautifully worked out all the internal characters connected with the type of this genus which abounds in the Devonian Beds of Ferque. The tube has not, however, been hitherto observed in any other species, and therefore we cannot affirm that

originating under the platform, extends longitudinally and freely with a slight upward curve to about a third of the length of the valve; to the inner extremities of the socket ridges are affixed the spiral horizontal cones, with their extremities directed towards the lateral margins of the shell; the crura appear to have been united before the lamellæ commence their spiral coils:[1] no defined septum is visible along the bottom of the valve, but a minute rudimentary mesial ridge which divides the quadruple impressions of the adductor.

In *the larger or ventral valve* the dental plates are more or less developed, exhibiting on and close to their inner sides, impressions of the pedicle muscles; the adductor leaves, a small oval scar separated by a minute mesial elevation under and outside of which are seen two other larger impressions due to the cardinal muscles.

Obs. Under Athyris I have mentioned all my reasons for the limitation here introduced, and shall therefore only add one or two other observations. Professor King separated from his genus *Cleiothyris*, certain shells which at least for the present I should wish either to include with *Spirigera*, or to place in a section of this last. The author proposes for these the term *Retzia*, with the following diagnosis:—"*A Spiriferidia; in general oval longitudinally, ribbed or striated, with large punctures; larger valve foraminated at or near the apex of the umbone, with a large triangular area, and a closed fissure.* Type—*T. Adrieni*, De Verneuil; *T. Baylii, Salteri, and Bouchardii*, Dav. *T. Oliviani. T. ferita*, is likewise mentioned.[2] I do not pretend that some of the shells here mentioned may not require to be separated and formed into a small sub-sectional group, but hitherto nothing has been seen or said regarding their interior; and in consequence its distinctive claims have not been sufficiently tested: much, indeed, has yet to be achieved before a multitude of Palæozoic species can be placed into their proper places, and which time alone can accomplish.

Geol. range.—The existence of this genus seems perhaps to have exceeded that of *Athyris;* appearing in the silurian epoch, it has continued up to the lower Lias, above which no examples have been discovered.

Examples: S. concentrica, V. Buch, sp.; *S. pectinifera*, J. Sow.; *S. Roissyi*, Def.; *S. lamellosa*, Def.; *plano-sulcata*, Phil., sp.; *serpentina*, Kon., sp.; *Hispanica, Ferronesensis*; *Esquerra*, Vern.; *axiocolpos*, Emmerich,[3] &c.

it always occurred. Professor King has figured the aperture in the hinge-plate of *T. pectinifera*, and I doubt not, that with time it will be recognised in many other species.

[1] This character has been well figured by J. De Carle Sowerby in *S. pectinifera*. Min. Con. T. 616.

[2] A Monograph of English Permian Fossils, p. 137, 1849.

[3] This species occurs in the lower or black Lias of Koessen (Tyrol), and has been clearly investigated by M. Suess, of Vienna, who kindly sent me his figures, and a description of this remarkable shell.

Genus—UNCITES, *Defrance*, 1828.

Type—U. GRYPHUS, *Schl.*, sp. Int., Pl. VII, figs. 79—86.

TEREBRATULITES (part), *Schloth.*
UNCITES, *Defrance*, and of the generality of Authors.
GYPIDIA (part), *Dalman*, 1828.[1]
TEREBRATULA (part), *V. Buch*, &c. (non *Llhwyd.*)

Animal unknown. *Shell* oval, elongated; valves nearly equally convex; *beak* long, produced, tapering and incurved at its extremity, hollow, and truncated in young specimens by a small oval foramen; no true area, a large concave deltidium partly surrounds the aperture and extends to near the cardinal edge; the umbo of the socket valve is considerably incurved and concealed by and under the deltidium of the other valve; the sides of the beak as well as of the umbo become in some examples considerably deflected inwards, producing deep, lateral, elongated, concave depressions, or pouches opening externally, and not communicating with the interior; valves articulating by means of teeth and sockets. In the interior of smaller valve, the calcified supports of the arms form two conical spires, attached close to the socket walls by crural processes; surface smooth or striated.

Obs. The genus *Uncites* was proposed in 1828 by Defrance,[2] and has been very generally admitted, although its true character had not been established. Several authors have endeavoured to define the section, but have evidently failed in their attempts. M. d'Orbigny's diagnostic[3] is essentially defective, since the beak was not, as he supposes, entire, but *hollow* and *truncated* (at least up to a certain period of the animal's existence), by a regular foramen, from which issued the pedicle of attachment: this point was proved beyond doubt by a series of examples of all ages I obtained from Nimes, near Couvin in Belgium.

The internal details are not yet completely known. The muscular impressions remain still to be ascertained; but we are indebted to Professor Beyrich, of Berlin, for the knowledge of the *spiral supports*, which he was so fortunate as to discover in a specimen from Paffrath, figured, with his permission, in Pl. VII, fig. 85.[4] The labial appendages were not therefore simply attached at their origin, as supposed by M. d'Orbigny, nor does the genus belong to the family of *Rhynchonellidæ*, but to that of the *Spiriferidæ*, and should be placed between *Atrypa* and *Athyris* (Retzia). The two singular lateral pouch-shaped

[1] Dalman proposed the term *Gypidia*, as a substitute for *Pentamerus*, Sow.! his first example was the *T. gryphus* of Schl., which is not a *Pentamerus*. Von Buch's synonymes of Uncites are very defective, as are also all his observations on the species.

[2] Dic. des Sciences Nat., *Uncites gryphoides*.

[3] Paléont. Franç., vol. iv, p. 347, 1847.

[4] I am indebted for the sketch of Professor Beyrich's specimen to my zealous friend M. Suess of Vienna.

depressions do not occur in all the specimens; they have been long known, and were figured in Blainville's 'Malacologie.'

Geol. range.—*Uncites* is at present known to occur only in the Devonian system, and seems to characterise a certain horizon.

Examples: U. gryphus,[1] Sch. sp. ? ; *lævis*, M'Coy.[2]

Genus—ATRYPA, *Dalman*, 1827.

Type—A. RETICULARIS, *Linn.*, sp. Int. Pl. VII, figs. 87—94.

ANOMIA (part), of *Linnæus*.
TEREBRATULITES (part), of *Schloth.*
TEREBRATULA, of the generality of Authors.
ATRYPA, of *Dalman*, (part), *King* and *Sow.*
SPIRIGERINA, *D'Orb.*, 1847, *M'Coy.*
TEREBRATULÆ CALCISPIRÆ, *Quenstedt.*
HIPPARIONYX (part), *Vanuxem.*

Animal unknown. *Shell* circular, transverse or elongated, furnished with internal spires, valves articulating by teeth and sockets; beak produced or incurved, and slightly truncated by a small round opening separated or not from the hinge-line by means of a deltidium; false area at times well defined, dental valve convex, or almost flat, with a longitudinal depression or sinus; *socket valve* convex, with or without a mesial fold; surface smooth, striated or variously costated and imbricated by squamose lines of growth, often considerably produced beyond the margin, under the shape of tubular spines or foliaceous expansions; structure fibrous and impunctate; *spiral appendages* originating at the base of the socket walls, and forming two large hollow cones placed horizontally, with their apices directed inwards and towards the hollow of the same valve, which they almost fill; the inner sides of the spires are pressed together and flattened, with their terminations close to each other near the centre of the bottom of the shell. In the interior of the *socket valve*, the quadruple impressions of the *adductor* muscle are separated by a medio-longitudinal ridge; the pedicle muscles were probably affixed to the two small cardinal plates. In the *dental valve* at the base of the teeth a semicircular ridge curves on each side, forming a saucer-shaped depression open in front, and into which were implanted the shell and pedicle muscles; the *cardinal* muscles seem to occupy the largest portion of the depression, and to have been divided by an obscure mesial ridge; beyond these and a little higher up are placed the pedicle muscular impressions, and above the mesial ridge, nearer the beak, is seen the oval scar left by the adductor.

[1] This species was figured and described by Beuth, as a *Terebratula*, in a work entitled 'Juliæ et Montium Subterranea,' &c., p. 134, No. 74, 1776. Professor Quenstedt likewise partly describes and figures the genus in his 'Handbuch der Petrefackunde,' 1851, pl. xxxvi, fig. 40, *a*, *b*, *c*.

[2] British Pal. Fossils of the Camb. Mus., pl. ii, A, fig. 6, 1852.

The vascular impressions in the *dental valve* consists of two principal trunks originating on each side between the cardinal and pedicle muscles: these soon divide into two primary branches which extend right and left almost parallel to the margin, and giving off at variable intervals smaller bifurcating veins, which are directed towards the edge of the shell.

Obs. Dalman founded the genus *atrypa*,[1] which he characterized as "*Inequivalve biconvex, hinge-line rounded, beak of larger valve covering the base of smaller valve, apex imperforate.*" Naming a number of examples,[2] the first and second being *A. reticularis* of Linn. and *aspera* of Schl.; but, unfortunately, these shells happen to have *perforation*, although the aperture is very often concealed by the curvature of the beak; the term *Atrypa* is therefore a misnomer, implying a zoological mistake, and should rightly be expunged; but many authors appear anxious to retain the name, *as a simple denomination*, casting aside its derivation, and considering alone the *first* or *typical species*. I have consented (against my own inclination) to adopt the term on the understanding that it will be restricted to those shells possessing the well-defined character of *A. reticularis*. M. d'Orbigny's name, *Spirigerina*, published in 1847, must therefore be considered as a synonyme.[3]

Many important characters distinguish and connect this genus with other sections; thus the beak of *Atrypa* bears resemblance to that of some *Terebratulæ*, being perforated by a circular opening partly surrounded by a deltidium; but this foramen is not visible in all examples of the same species, from the beak touching and overlying the umbo of the other valve, the animal was therefore probably unattached or free during a portion of its existence. To *Rhynchonella*, it seems allied by the arrangements of its muscular system, but not by those of its labial appendages, which in the last-named genus were free or affixed only at their origin, while those of *Atrypa* were supported by large spiral appendages,[4] so that the section may be said to combine characters belonging to *Spirifer*, *Rhynchonella*, and *Terebratula*, so as to constitute an organisation different from each in some particular. Out of the list of species placed in *Atrypa* by Dalman, three only can be

[1] *Petrefacta suecana* in the 'Konigl. Vet. Acad. Handl.' for 1827, published in 1828 (*a*, privative, and *τρυπα*, foramen).

[2] As observed by Professor King, in the 'Ann. and Mag. of Nat. Hist.,' vol. xviii, p. 29, 1846. Dalman included some very different shells in his genus, *A. gallata*, belonging to Sowerby's *Pentamerus*, and *A. nucella* to Fischer's *Rhynchonella*, &c.

[3] In his work on the 'British Pal. Foss. of the Camb. Mus.,' Professor M'Coy adopts M. d'Orbigny's name *Spirigerina* in preference to *Atrypa*, but retains his own name *Athyris*, the derivation of which is quite as objectionable as that of Dalman.

[4] The spires of *A. reticularis* and *prunum* have been known for several years, and figured by Blainville, V. Buch, and Quenstedt, &c.; the last-named author, in his 'Handbuch der Petrefackunde,' 1851, proposes to place *A. reticularis* and *prunum* in a group termed "*Terebratulæ calcispiræ*," but the shells in question differ so essentially from *Terebratula* proper, as to require a separate denomination, and to be removed from that family.

retained. The author also forms two divisions in his genus, viz. *striatæ* and *lævis; A. reticularis*, and *aspera*, being the types of the first, *A. prunum* of the second.

Geol. range.—The genus first appeared during the Silurian period, and continued in the Devonian epoch, above which no authenticated example has been observed.

Examples: *A. reticularis*, Linn. sp.; *aspera*, Schl.; *spinosa*, D'Orb.; *marginalis*, Dalman, sp.; *comata*, Barr.; *prunum*, Dalman,[1] &c.

Family—KONINCKINIDÆ.

Animal unknown; *shell* free; valves unarticulated? oral arms supported by two lamellæ spirally coiled.

Obs. Only one genus and species is at present known, which had formerly been classed among the *Productidæ*, but from which it has been since removed, on account of its peculiar internal organisation. I have placed it directly after the *Spiriferidæ*, on account of the spiral lamellæ observed in its interior, which bear some resemblance to those of Atrypa.

Genus—Koninckina, *Suess*, MS., 1853.

Type—K. Leonhardi, *Wissmann*, sp., 1841. Int., Pl. VIII, figs. 194—198.

Productus, *Wissman*,[2] *Münster*,[3] *Klipstein*, *De Koninck*,[4] &c. (part.)

Shell nearly circular, inequivalve, compressed; *larger or ventral* valve convex or gibbous, with a slight longitudinal depression; beak considerably incurved, with auricular expansions; *smaller* or dorsal valve concave, following the curves of the other; surface smooth; no area or deltidium; valves unarticulated? in the interior of *dorsal* valve a mesial ridge extends from the cardinal process to the frontal margin; arms or oral appendages supported by a spiral calcified lamella?

Obs. All the authors who have described this remarkable shell have placed it in *Productus*, although it possesses, in reality, none of the internal characters peculiar to that genus. Dr. Klipstein[5] has observed that it possessed internal traces of the spiral arms, and figures large spiral ridges. Having had an opportunity of examining, along with

[1] M. d'Orbigny places this species into *his* genus *Atrypa* (Prod., p. 37), and it must likewise be observed, that the French author's genus *Atrypa* is made up of a strange assemblage of dissimilarly organised forms, and which do not possess the characters assigned to them in vol. iv of the 'Paléont. Franç.;' most of M. d'Orbigny's *Atrypa* are shells with spirals, and belong to the same section into which he places *tumida*, viz., SPIRIGERA.

[2] Beitr. zur Petrefacten, Von Münster, vol. iv, p. 18, pl. vi, fig. 21, 1841.

[3] Ibid., p. 68, fig. 24, *P. dubia?* 1841.

[4] Recherches sur les Animaux Fossiles, 'Mon. des Productus,' p. 167, pl. xvii, fig. 4, 1847.

[5] Beitr. zur Geol. Kenntn. der Ostl. Alpen., p. 236, pl. xv, figs. 20 and 21*a*, *Prod. alpina*, 1845.

Mr. Woodward, the German author's typical specimens now belonging to the British Museum, I communicated on the subject with my Viennese friend, M. Suess, who had likewise examined a number of examples under more favorable circumstances, and I was informed by him that the arms were really supported by free calcareous spiral lamellæ, which he had succeeded in taking out in single bits, and kindly forwarded the interesting sketches reproduced in my plate, also requesting me to adopt his generic appellation, *Koninckina;* so compressed are the valves that scarcely any room existed for the animal, and slight impressions of the arms seem to have been reproduced by the mantle on the larger or ventral valve; traces of the vascular impressions have also been discovered by M. Suess, but there still remains a few internal points to be made out relative to the hinge line and muscular system.

Geol. range.—Hitherto only known in the triassic beds of St. Cassian.

Examples: The only species is the *K. Leonhardi*, Wissman, sp.

Family—RHYNCHONELLIDÆ.

Animal free, or attached by a muscular pedicle issuing from an aperture situated under the extremity of the beak, in the larger or ventral valve; oral appendages spirally rolled, flexible, and supported only at their origin by a pair of short-curved shelly processes; structure fibrous, and impunctate.

Obs. This family is composed of the three genera, *Rhynchonella, Camarophoria,* and *Pentamerus.* It was represented from the first epoch of animal life, and has continued to exist through the whole geological scale: two species are still found alive in our seas.

Genus—Rhynchonella, *Fischer*, 1809.[1]

Type—R. loxia, *Fischer.* Int., Pl. VII, figs. 99—107.

Anomia (part), *Columna*, 1616, *Linnæus*, and some other Authors.
Trigonella, *Fischer*, 1809.
Rhynchonella, *Fischer*, 1809, (part), of *D'Orbigny* and the generality of modern Authors.
Terebratula (part), *Deshayes*, and of many Naturalists.
Terebratulites (part), of *Schlotheim.*
Cyclothyris (*C. latissima*), *M'Coy.*
Atrypa (part), of *Dalman*, &c.
Hypothyris, *Phillips*, 1841, *Morris, King*, &c.
Hemithyris (part), *D'Orbigny* and *M'Coy.*
Acanthothyris (part), *D'Orbigny.*

Animal free, or attached to submarine objects by means of a pedicle; visceral mass confined to a small space near the umbones, and separated from the general cavity of the shell by a strong *aponeurotic* membrane. The mouth is situated in the centre of this membrane, supported by the apophysary processes of the dorsal valve; the upper lip is

[1] Notice des Foss. du Gouv. de Moscow, 1809.

plain, the lower cirrated; both are united at the sides of the mouth, and form long appendages (or *labial arms*), coiled up spirally, with their ends directed inwards towards the cavity of the dorsal valve. The alimentary canal takes the same course as in *Ter. australis*, passing through the deeply-notched hinge-plate, and ending behind the point of insertion of the adductor muscle in the centre of the ventral valve. The pallial veins (like those of *Rh. acuminata*, p. 95, figs. 33, 34, and *Camarophoria*, p. 97, figs. 35, 36,) are much narrower than in *Terebratula*, and more angular in their mode of bifurcation; there are four principal branches in each lobe, opening into large sinuses similar to those of *Orthis* and *Strophomena*, but smaller in extent. The margin of the mantle is fringed with a few short horny *setæ*. The muscles are essentially like those of Terebratula; their impressions are referred to in the description of the shell. *Shell* inequivalve, variable in shape, transverse or elongated, circular or trigonal; valves more or less convex, with or without a mesial fold and sinus; beak entire, acute, prominent, or so much incurved as to leave no free space for the passage of pedicle muscles; foramen variable in its dimensions and form, placed under the beak, exposed or concealed, entirely or partially surrounded by a deltidium, the aperture being sometimes completed by a portion of the umbo of the smaller valve; *deltidium* in two pieces, at times either extending in the form of a tubular expansion, or rudimentary; surface striated or plaited, rarely smooth; structure fibrous, impunctate. Valves articulating by means of two teeth in the larger (ventral), and corresponding sockets in the imperforated (dorsal) valve; apophysary system, in smaller or dorsal valve, composed of two short, flattened, and grooved lamellæ, separate and moderately-curved upwards, attached to the deeply divided hinge-plate; in the *socket valve* the quadruple impression of the adductor muscle is clearly defined, and separated by a short medio-longitudinal ridge (*s*); the pedicle scars occupy the small cardinal plates, between which is the small and narrow cardinal process. In the perforated valve the two strong diverging cardinal teeth are supported by dental plates extending to the bottom of the valve, and at the base of these a semicircular ridge curves on each side, forming a more or less defined saucer-shaped depression, into which were affixed the shell and pedicle muscles; these last leave two narrow elongated scars, close to the inner base of the dental laminæ, the remaining and largest portion being chiefly occupied by the *cardinal* muscles, which are longitudinally divided by a small raised ridge; above these again is seen a small oval scar due to the adductor.

Fig. 32.

Rh. nigricans.[1]

Fig. 31.

Fig. 30.

Rh. psittacea.

a, adductor. *f, foramen.* *d, deltidium.* *t', sockets.*
i, intestine. *t, teeth.* *a, adductor.* *r, cardinal.*
p, pedicle muscles. *o, ovarian spaces.*
c, crural processes. *s, septum.*

[1] From Mr. Evans's specimen, see note to p. 57. The original was very unsymmetrical.

Obs. Having in Part III, p. 65, entered fully into the history and reasons for adopting the term *Rhynchonella*, in preference to other names subsequently proposed, I shall only add that I cannot coincide in Professor M'Coy's views on the supposed distinctions between this genus and that proposed by M. d'Orbigny, under the name of *Hemithyris*, since from an attentive examination of the interior of both *R. psittacea* (*Hemithyris*, D'Orb.) and *R. octoplicata* (*Rhynchonella*, D'Orb.), it will be easily perceived that both were provided with similar dental plates, and, in fact, with every essential external and internal character or detail of organisation; nor has M. d'Orbigny proved that his so-termed genus varied in any one important character. Professor M'Coy states that in *Hemithyris*, "the foramen is triangular, and not separated from the hinge," nor is it so in several admitted *Rhynchonellæ* (*R. concinna*, &c.), in which the foramen is partly completed by the umbo, the deltidial plates being lateral, and only rudimentary, as seen in the recent *R. psittacea* and *nigricans;* in the Palæozoic as well as Oolitic species we find some forms in which the beak is so much incurved, as to exhibit no aperture or passage for pedicle fibres, proving that the animal may have lived free during perhaps the whole, or a portion of its existence. Professor M'Coy is also mistaken while stating, in his 'Brit. Pal. Fossils,' that I refer *Hemithyris* to *Hypothyris* of Phillips; on the contrary, I clearly stated that I saw at that period no good reasons for adopting either of these denominations; besides which, Professor M'Coy gives examples of *Hemithyris*, which do not even possess the internal characters of his diagnosis.

Geol. range.—The genus *Rhynchonella* is one of the oldest types of animal life, having been repeated from the Silurian epoch up to the present period: two species are still found alive.

Examples: R. acuta, Sow., sp.; *antidichotoma*, Buv., sp.; *concinna*, Sow., sp.; *Cuvieri*, D'Orb.; *decorata*, Schl., sp.; *furcillata*, Theodori, sp.; *plicatella*, Sow., sp.; *octoplicata*, Sow., sp.; *plicatilis*, Sow., sp.; *tetrahëdra*, Sow., sp.; *psittacea*, Chemnitz, sp.; *nigricans*, Sow., sp.; *Bouchardii*, Dav.; *acuminata*, Martin, sp.;[1] *pugnus*, Martin, sp.; *lacunosa*, Lin., sp.; *Wilsoni*, Sow., sp.; *spinosa*, Schl., sp.; &c. &c.

[1] In *R. acuminata*, the arms were attached to small curved lamellæ, similar to those of all the Rhynchonellæ; a beautiful example may be seen in the Museum of Practical Geology. I have thought that it might be interesting to introduce figures of two remarkable internal casts, on which the muscular scars, ovarian spaces, and vascular impressions are beautifully illustrated.

Fig. 33.

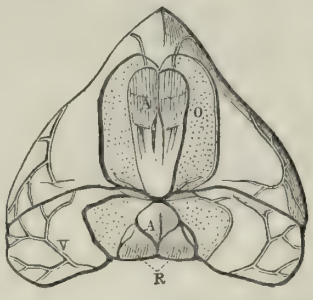
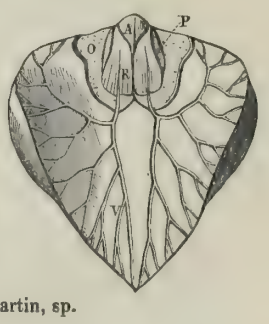


Fig. 34



Rh. acuminata, Martin, sp.

Fig. 33 is taken from a specimen belonging to Professor King: the view is drawn, as seen from the beaks, with the smaller or dorsal valve uppermost: A, *adductor;* R, *cardinal muscles;* O, *ovarian spaces;* V, *vascular impressions.*

Fig. 34 shows, in a beautiful manner, the impressions due to the vascular system in the dental or ventral valve, and has been drawn from a specimen in the collection of Mr. Morris.

Genus—CAMAROPHORIA, *King*, 1844.

Type—C. SCHLOTHEIMI, *V. Buch*, sp. Int., Pl. VII, figs. 108—113.

TEREBRATULA (part), of the generality of Authors.
RHYNCHONELLA (part), of *M. d'Orbigny*.

Animal unknown; *shell* of a subtrigonal shape, with convex valves longitudinally divided by a sinus and mesial fold; beak entire, acute, more or less incurved, under the extremity of which a small fissure is sometimes exposed; no area or deltidium; surface generally plaited, with or without marginal expansions; shell structure impunctate;[1] valves articulating by means of teeth and sockets.

In the *perforated valve*, the dental plates are conjoined at their dorsal margins, forming a trough-shaped process affixed to a low medio-longitudinal plate. In the *smaller valve*, the space between the sockets is occupied by a small cardinal muscular protuberance or boss, on either side of which two long slender processes curve upwards, to which were, no doubt, attached the free cirrated spiral fleshy arms; from beneath the cardinal process, a high vertical mesial septum extends to a little more than a third of the length of the valve, supporting along and close to its upper edge a spatula-shaped process, considerably dilated towards its free extremity, and projecting with a slight upward curve to nearly the centre of the shell.

Obs. We are greatly indebted to Professor King for the knowledge we possess of this genus.[2] Its affinities both to *Rhynchonella* and *Pentamerus* are obvious, and its natural place between the two did not escape the scrutiny of the learned Professor, who observed that the form of the trough and supporting plate of the larger or ventral valve in *Camarophoria* bears a striking resemblance to the same in *Pentamerus*, but that the apophysary system in the dorsal valve of the last-named genus "consists of two socket-plates largely developed, and passing to a considerable distance into the cavity of the shell. Whereas, in *Camarophoria*, it appears to consist of a medio-longitudinal plate, equally as much developed and expanded bilaterally at its free or upper margin. That although related to *Pentamerus*, *Camarophoria* is also closely allied to *Rhynchonella*,[3] especially in external form; the only difference is in their internal structure, *Rhynchonella* having the dental plates completely separated, and divaricating, as in *Orthis*, and the same amount of dissimilitude prevails between the apophysary system belonging to the small valve of both

[1] Dr. Carpenter's Microscopic Examination of the Shell Structure is different from that published by Professor King, ('Mon. of English Permian Fossils,' p. iv.)

[2] Refer for extended details to Professor King's description of the genus, in the 'Ann. and Mag. of Nat. Hist.,' July, 1846, and to the same authors 'Mon. of Permian Fossils of England,' p. 113, 1849.

[3] The term *Hypothyris* is here made use of by Professor King, but as that appellation is considered to be a synonyme of *Rhynchonella*, I have preferred this last to the name introduced by the Professor.

genera. In *Rhynchonella* it simply consists of the homologues of the crura of the loop starting from within the *socket plates*, which are rarely developed to any extent, offering, in this respect, a striking contrast with the large size of the corresponding structures of *Pentamerus*." But while agreeing so far with the founder of the genus, neither Mr. Woodward nor myself can entirely coincide with the views expressed on the muscular arrangement; the *adductor*, according to my learned friend, would have been fixed to the trough process of the larger valve, and to the spatula-shaped one of the smaller valve, while we feel disposed to consider that the second attachment took place at or close to the base of the septum in the smaller or dorsal valve;[1] the spatula-shaped process serving on the contrary as a visceral support; the cardinal muscles are supposed to have been fixed to the cardinal process or boss, and to near the base of the septum in the ventral valve. The vascular system is beautifully displayed on internal casts of *C. multiplicata*, as seen in the annexed diagrams, reduced from those published in the 'Monograph of English Permian Fossils.'

Fig. 35. Fig. 36.

Camarophoria multiplicata.

Geol. range.—But few species of this genus have as yet been discovered, although I firmly believe their number will increase with future researches: for the present authenticated examples are only known to occur in the *Carboniferous*? and *Permian* deposits.

Examples: C. Schlotheimi, V. Buch, sp.; *C. globulina*, Phillips, sp.; *C. multiplicata*, King; and *C. crumena*? Martin, sp., according to Professor King, &c.

Genus—PENTAMERUS, *Sowerby*, 1813.

Type—P. KNIGHTII, *Sow.* Int., Pl. VII, figs. 114—119.

ANOMIA (part), of *Linnæus.*
PENTAMERUS, of the generality of Authors.
TEREBRATULA (part), of some Palæontologists.
ATRYPA (GALEATA), *Dalman.*
GYPIDIA (part), *Dalman.*

Animal unknown; *Shell* ovate, somewhat pentagonal, elongated or transverse, and articulated by means of teeth and sockets, rarely with any hinge line or area; *dental or ventral valve* in general the most convex, with or without a mesial fold or sinus; beak

[1] Professor King informs me, that he considers those impressions situated on each side of the septum in either valve of *Camarophoria* to be due to ovarian or genital organs, and refers to what is seen on a specimen of *R. acuminata*, of which we have given a woodcut (p. 95, fig. 33.) It appears to me that the rounded areas (fig. 35) on each side of the umbonal fissure, in the casts represented above, are more probably the ovarian spaces.

acute, entire and much incurved, concealing a triangular fissure rarely exposed except in the young state, and over which the umbo of the socket valve is greatly incurved; no area or deltidium; exterior smooth, striated, or ribbed. Inside the *larger valve*, two contiguous vertical septa coalesce into one median plate, extending from the beak to a greater or less distance; and then diverge and form the dental plates, inclosing a triangular chamber of much smaller dimensions than the lateral ones.

In the interior of the *smaller valve*, instead of a single median plate there are two distinct longitudinal septa of variable dimensions; (between which a small median ridge is occasionally found), to these the socket walls converge and join, forming two more or less developed and inclined plates, to the produced extremities of which were affixed the spiral cirrated arms. These plates often form a deep V shaped chamber corresponding with the similar chamber in the opposite valve, and the edges of the two chambers are applied against each other, so as to leave a rhomboid cavity between them.

Obs. The genus, *Pentamerus* was judiciously proposed by Sowerby;[1] but not always well understood by subsequent authors. Dalman[2] objected to Sowerby's name, on the ground that the shell was not five chambered, and proposed as a substitute that of *Gypidia*. Since then the minute and valuable researches of M. de Verneuil,[3] Professor King,[4] Barrande,[5] M'Coy,[6] Suess, Salter, and others, have materially augmented our knowledge of the internal dispositions and affinities which *Pentamerus* bears to other genera. By the dispositions of the septa and dental plates in the ventral valve, it is closely related to *Camarophoria*. The position of the mesial plate and V shaped process in the dental valve has been clearly shown, both by Baron v. Buch and Professor King, to be the equivalent of the mesial septum and dental plates of other genera; the dimensions of these varying almost in every species; they are most developed in *Pentamerus Knightii*, where the central septa extend nearly to the frontal margin, while in other forms, such as *P. lens*, the same plates are small and rudimentary;[7] affording, as justly remarked by Professor M'Coy, good specific characters. The same proportions and differences are likewise observable in the arrangements of the smaller valve; in *Pent. Knightii*, for example, the two sub-parallel longitudinal septa as well as the conjoined and inclined dental plates, are much extended and elevated, while in other forms they are considerably reduced, being almost rudimentary. Mr. Salter has observed that in *P. lens* the dental plates extend freely into the cavity of the shell, and that in (*P. liratus*)

[1] Min. Con., vol. i, 1813. [2] *Petrefacta suecana*, in 'Kongl. Vet. Acad. Handl.,' 1827.

[3] Geology of Russia and the Ural Mountains, vol. ii, 1845; and Count Keyserling's Wissenschaftliche Beobachtungen, 1846.

[4] Annals and Mag. of Nat. Hist., vol. xviii, 1846; and Mon. of Brit. Permian Fossils, 1849.

[5] Uber die Brachiopoden der Silurischen Schichten, &c., 1847.

[6] Brit. Pal. Fossils in the Camb. Mus., 1852.

[7] See also the descriptions *P. lens, oblongus, undatus, microcamerus*, by M'Coy, 'Brit. Pal. Fossils in Camb. Mus.,' p. 209, &c.

they are produced in the form of free, long, and narrow lamellæ, to which the cirrated arms were of course attached. The exact position and form of the different muscles has not been yet completely made out; but in some species the quadruple impressions of the adductor are clearly defined.

Geol. range.—The genus first appeared in the lower Silurian epoch, and continued, uninterruptedly, to the carboniferous period, above which no authenticated example has been yet discovered.

Examples: P. Knightii, Sow.; *conchidium*, Linn., sp.; *borealis*, Eichw., sp.; *galeatus*, Dal., sp.; *Vogulicus*, Vern.; *linguiferus*, Sow.; *Sieberi*, Barr.; *oblongus*, Sow.; *oblatus*, Barr.; *pelagicus*, Barr.; *caducus*, Barr.; &c.

Sub-Family? PORAMBONITIDÆ.

Animal unknown, but evidently attached, at least during a portion of its existence, by a muscular pedicle; no calcified process for the support of the oral appendages, which were probably fleshy and spirally coiled. In the interior of each valve two diverging septa originate from within the beaks; structure fibrous and impunctate.

Obs. As so little is known of the internal organisation of the curious shells composing the genus *Porambonites*, I have not ventured to follow M. d'Orbigny and Prof. King, in placing it in the family *Rhynchonellidæ;* but preferred, for the present, to leave it by itself in a small sub-family. Its place is, however, I believe between the *Rhynchonellidæ* and *Strophomenidæ*.

Genus—Porambonites, *Pander*, 1830.[1]

Type—P. æquirostris, *Schl.*, sp. Int., Pl. VII, figs. 120—126.

Terebratulites (æquirostris), *Schl.*
Terebratula (part), *V. Buch.*
Spirifer (part), of *Eichwald* and *V. Buch.*
Porambonites, of *Pander*, *D'Orbigny*, *M'Coy*, and *Sharpe.*
Spiriferes anormaux, A. æquirostres, *De Verneuil.*[2]
Isorhynchus, *King*, 1849.[3]
Orthis (part), *Quenstedt.*

Animal unknown; *shell* circular, transverse or elongated, globose, sub-equivalve; valves articulating by teeth and sockets; beaks slightly unequal, rather more produced in dental valve, with a small area in each, generally rudimentary, and perforated by a

[1] Beiträge zur Geog. des Russischen Reiches, 1830.

[2] In the Geol. of Russia and the Ural Mountains, vol. ii, 1845. M. de Verneuil places the shells belonging to Pander's genus among his *abnormal Spirifers*, forming two subdivisions, which he distinguishes as *A. æquirostres* (*Porambonites*) and *B. Biforés*, these last belonging to the genus *Orthis*.

[3] From being unacquainted with Pander's type and priority, Professor King proposed, in 1849, the name *Isorhynchus*, which the author now admits to be a synonyme.

mesial elongated triangular fissure, which truncates the beak of the larger valve before extending to the hinge line; surface pitted, but the shell structure impunctate;[1] in the interior of *larger* or *ventral valve* the dental plates form two slightly elevated and diverging septa, extending to a greater or less distance along the bottom of the shell. In the other valve the socket plates form likewise diverging septa, extending also to a variable distance.

Obs. The genus *Porambonites* was proposed by Pander for a remarkable group of shells which abound in the neighbourhood of St. Petersburgh, but from the difficulty of obtaining interiors, they have been differently interpreted by several authors. M. de Verneuil seems uncertain as to the place these shells should occupy, since he states that he considers them to be nearer related to *Spirifer* than *Terebratula*, although removed by various characters, and principally by the septa of the socket valve, so that they might equally well be classed with *Orthis*. Since then M. d'Orbigny[2] has replaced the shells in Pander's genus, and admitted them into his family of *Rhynchonellidæ*, from a belief that the free spiral fleshy arms were probably fixed to the socket plates. From the beaks being in general so much incurved as almost to come in contact, the extent of the foramen or fissure is concealed, so that some authors, as for instance M. d'Orbigny and Professor King,[3] state only one of the beaks to be foraminated, while, on the contrary, M. de Verneuil,[4] Professor M'Coy,[5] Dr. Volborth,[6] and Professor Quenstedt,[7] believe that both possessed a foramen or fissure. Some additional light on the internal arrangements has been obtained through Mr. Sharpe's fortunate discovery of several internal casts of a Portuguese species (*P. Ribeiro*); we have figured, with that gentleman's permission, in Pl. VII, figs. 225-26, one which exhibits, in a beautiful manner, not only the dental and socket plates, but the position of the muscles and vascular impressions, not hitherto observed in any of the other forms; but the internal details of the different Russian species, require still further examination before the exact character of the genus will be completely known.

Geol. range.—The genus seems to be confined to the lower Silurian period.

Examples: *P. æquirostris*, Sch., sp.; *intercedens*,[8] Pander; *reticulatus*, V. Buch, sp.; *Ribeiro*, Sharpe, &c.

[1] The depressions or dots visible on the surface of the different species were found by Dr. Carpenter to be simply due to external sculpture, the shell structure being impunctate.

[2] Considérations Zool. et Geol. sur les Brach., in the 'Comptes rendus Heb. de l'Acad. des Sciences of Paris,' 1847; and Paléont. Franç. Ter. Crétacés, vol. iv.

[3] A Monograph of English Permian Fossils, p. 112, 1849.

[4] Geol. of Russia and the Ural Mountains, vol. ii, 1845.

[5] British Pal. Fossils in the Camb. Museum, p. 212, 1852.

[6] This gentleman has informed me, "that the *area* is in general so small as hardly to deserve the name, but that the triangular fissure is large and the teeth developed."

[7] Handbuch der Petref., p. 486, 1851. The author states that both beaks are perforated at their extremities: he likewise illustrates a fragment of the interior of one of the species, in pl. xxxix, fig. 5.

[8] Pander describes many species which have turned out to be mere varieties and synonymes. It is likewise doubtful, if the *Sp. Tcheffkini* of De Verneuil belongs to this genus.

Family—STROPHOMENIDÆ.

Animal unknown, some of the group appear to have lived free; others were fixed during the whole or a portion of their existence by means of a muscular pedicle; no calcified supports for the arms, which were no doubt fleshy and spirally coiled; shell with a straight hinge line, and a low triangular area in each valve; valves both convex, or with the dorsal or ventral one concave or convex; shell structure fibrous or punctated.

Obs. Much difference of opinion has been expressed as to what genera the present family should include, as well as to the name it should retain. Some authors, M. d'Orbigny, Professor M'Coy, &c. prefer that of *Orthisidæ*, (properly *Orthidæ*) while others, such as Professor King, advocate *Strophomenidæ*. I have admitted this last denomination more on account of its priority, than on any other consideration. As to the subdivision of the group, we have considered, that in the present state of our knowledge, it would be preferable to restrict the number of genera to four, viz., *Orthis*, *Orthisina*, *Strophomena*, and *Leptæna*. Professors M'Coy and King have admitted within its limits *Chonetes*, a genus, as I hope to prove, more nearly related to the *Productidæ*, and I am happy to be able to state, that the last-named author has expressed approval of my conclusions. *Porambonites* has likewise by some been placed in the present family; and although I am not prepared positively to deny such a view, I would defer its admission until more is known regarding its internal organisation. M. d'Orbigny is decidedly in error when placing *Leptæna* in one family, and *Strophomena* in another.

This is one of the oldest families, having originated in the lower Silurian epoch, and continued to exist to the end of the Liasic period, where hitherto the latest representatives have been found.

Genus—Orthis, *Dalman*, 1827.

Type—O. calligramma or O. elegantula, *Dal.*[1] Int., Pl. VII, figs. 127—135, and Pl. VIII, figs. 136—148.

Hysterolithus, of *Worm*, 1655; of *Linnæus*, 1753.
Anomia (part), of *Linnæus*.
Orthis, of *Dalman*, and the generality of Authors.
Spirifer of some Authors.
Terebratula (part), of *Deshayes*.

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[1] Dalman's first mentioned example is the *O. zonata*, which he figures with an *open* fissure. M. de Verneuil refers this species to *O. ascendens*, Pander; but in this last, the fissure is entirely covered by a deltidium, and does not agree in this respect with Dalman's figure. *O. callactis* or *O. calligramma* may be considered types.

Productus (part), of *Pander* (not of *Sow*).
Platystrophia, *King*.
Dicœlosia, *King*.
Schizophoria, *King*.[1]

Shell variable in shape, subcircular or quadrate; valves equally or unequally convex; socket valve sometimes slightly concave, with or without a mesial fold or sinus; hinge line straight, generally shorter than the width of the shell; both valves furnished with an *area* divided by a triangular open fissure for the passage of the pedicle fibres; beaks more or less incurved, that of the larger valve generally more produced; surface smooth, striated, or ornamented by simple, bifurcated, or intercalated ribs; structure minutely or largely punctated; valves articulating by means of teeth and sockets. In the interior of the *larger* or *ventral valve* the vertical dental plates form the walls of the fissure, and extend from the beak to the bottom of the shell; between these a small rounded mesial ridge divides the muscular scars which extend over two elongated depressions margined on their outer side by the prolonged bases of the dental plates; the cardinal muscles appear to have occupied the greater portion of the anterior division of these two depressions, the pedicle muscles occupying the external and posterior part of the same space; the adductor was probably attached to each side and close to the mesial ridge. In the socket valve the fissure is partially or entirely occupied by a more or less produced simple shelly process,[2] to which were affixed the cardinal muscular fibres; the inner socket walls are considerably prolonged into the cavity of the shell, under the shape of projecting laminæ, to the extremity of which free fleshy spiral arms may, perhaps, have been affixed. Under this shelly process a longitudinal ridge separates the quadruple impressions of the adductor, which on each side forms two deep oval depressions, placed obliquely one above the other, and separated by lateral ridges branching from the central one; the pallial vessels, as well as their numerous minor bifurcations or veins, have often left impressions within the valves; the principal trunks seem both more numerous and better defined in the socket valve,—after extending in a somewhat radiate or sub-parallel direction from the muscular scars to near the anterior region, they sweep round sub-marginally on both sides of the valve, leaving wide ovarian spaces, and giving off a series of smaller branches.

[1] I am requested by Professor King to state that from not having been acquainted with Dalman's original work 'Petrefacta Suecana,' in the Proc. of the Royal Acad. Sc. of Stockholm, he had not perceived that the author had placed marks of doubt after his first two types of *Orthis*, otherwise he would not have proposed the term *Schizophoria*, which he now considers as a synonym of *Orthis*. This mistake he attributes to Hisinger having omitted Dalman's marks of doubt.

[2] Some authors term the bifid or trifid cardinal process a "*rostral tooth*;" but I strongly object to such a denomination, since the only true teeth are those existing in the dental valve, and the shell does not articulate by means of the bifid projection, which was in all probability destined, as in other genera where it exists, for the attachment of the cardinal muscles.

Obs. In 1827, Dalman proposed the genus ORTHIS for a group of shells which he compared to the *Scallop*, but placed a mark of doubt after his first two types, viz., *O? pecten* and *O? striatella*, his examples being in bad condition, so that he was not certain if they really belonged to the genus; but to his following types he placed no mark of doubt. *O. zonata*, *callactis*, *calligramma*, *elegantula*, &c., must therefore be considered the typical forms of *Orthis;* besides which, the first two species mentioned belong to different genera, neither of which agree with such shells as *O. zonata* or *O. calligramma*.

The genus *Orthis* forms a well-characterised natural group, abounding in species and easily recognised. In 1848,[1] I stated that the species described by various authors as *Spirifer biforatus* or *Lynx*, and *Sp. bilobus* or *cardiospermiformis*, did not belong to the genus *Spirifer*, but to that of *Orthis*, since they possess *all* the essential characters of Dalman's genus, and none of those peculiar to the *Delthyridæ* or *Spirifers*. My views were adopted by M. de Verneuil,[2] D'Orbigny,[3] Professor M'Coy,[4] and Mr. Salter;[5] but Professor King not being convinced of their correctness, proposed, in 1849, the appellations of PLATYSTROPHIA for *O. biforata*, and DICŒLOSIA for *O. biloba*,[6] but to which sections the learned Professor does not I believe, at present, attach such great importance. I still, therefore, maintain my first view, which will be better understood by a glance at the respective figures (Pls. VII and VIII).

Geol. range.—*Orthis* is one of the oldest forms of animal life, having first appeared in the lower Silurian epoch, and continued uninterruptedly to the carboniferous period, above which we are not at present acquainted with any well-authenticated example, although some authors have most erroneously quoted it as occurring in the cretaceous, tertiary, and recent state; but an examination of the types of those so-called *Orthides* will soon convince any one that they do not possess the essential characters of the genus.

Examples: O. calligramma, Dal.; *testudinaria*, Dal.; *elegantula*, Dal.; *biloba*, Linn., sp.; *hybrida*, Sow.; *rustica*, Sow.; *Lewisii*, Dav.; *Bouchardii*, Dav.; *æquivalvis*, Dav.; *Michelini*, Lev.; *opercularis*, Vern.; *reversa*, Salter; *Gervillei*, Def., sp.; *palliata*, Barr.; *mulus*, Barr.; *Beaumontii*, Vern.; *obtusa*, Pander, sp.; *Dumontieri*, Vern.; *striatula*, Schl., sp.; *Lynx*, Eich.; *biforata*, Schl.; *resupinata*, Martin, sp.;[7] *Lyelliana*, De Koninck; &c.

[1] Bull. de la Soc. Géol. de France, vol. xxi, 2d ser., 1848. [2] Ibid.

[3] Prodrome de Paléontologie Stratigraphique, vol. i.

[4] British Palæozoic Fossils of Mus. Camb., 1852.

[5] Mem. Geol. Surv., vol. ii, part 1, 1848.

[6] A Monograph of British Permian Fossils, 1849.

[7] Among the Carboniferous Brachiopoda in the Museum of the Geol. Soc., may be seen two very remarkable *ventral* or *dental* valves, which had been discovered by Mr. J. Yates, at Llanymynech, and which I am inclined to believe may have belonged to a species of *Orthis*, bearing great external resemblance to that form known by the name of *O. resupinata*, Martin, sp. These valves are most remarkable from their very large and deep *cardinal* and *adductor* muscular impressions, the last mentioned

Genus—ORTHISINA, *D'Orbigny*, 1849.

Type—O. ADSCENDENS, *Pander*, sp., 1830. Int., Pl. VIII. figs. 149—156.

ANOMITES, *Schloth.* (part).
ORTHIS (part), of the generality of Authors.
HEMIPRONITES and PRONITES, *Pander*, 1830.
ORTHISINA, *D'Orbigny, King, M'Coy.*
STREPTORHYNCHUS, *King*, 1849.

Animal unknown; *shell* semi-circular or subquadrate, with unequally convex valves, external surface variously striated and marked by numerous concentric lines of growth, sometimes projecting in the shape of pectinated lamellar expansions; shell structure impunctate; hinge-line straight, not quite so long as the width of the shell; area double, larger in the dental valve, straight or bent back at right angles to the valves; the fissure in both is entirely covered by a convex deltidium, which in the larger valve of a few species is perforated near its extremity by a circular foramen; the valves articulate by means of teeth and sockets. In the interior of the *dental* or *ventral valve*, the muscular impressions occupy an area bordered by the raised edges of the dental lamellæ, and divided by a short mesial ridge. In the interior of the *socket* or *dorsal valve*, a longitudinal median ridge occurs, and the adductors, in the shape of two pairs of transversely oval scars, are placed one above the other on each side of this ridge.

Obs. Palæontologists do not seem yet to have completely agreed as to the propriety of separating the shells above described from ORTHIS. M. de Verneuil[1] has placed them in several of his sub-divisions of Dalman's genus: they constitute his *Rectostriatæ*, with their fissures closed by a deltidium; but this last-named character, combined with other internal differences as well as the structure of the shell, renders it very desirable to separate the shells under notice from ORTHIS proper, which has always the fissure in both valves entirely open, with widely divergent and prominent inner socket ridges, a small cardinal process, and a slight difference in the muscular impressions. Pander[2] divided his species of *Orthis* into several sections, viz.: *Orthambonites, Gonambonites, Hemipronites,* and *Pronites,* the last two or three names referring to forms with a covered deltidium.

being divided by a more or less elevated mesial ridge or septum. The enormous thickness of the valve may be judged from the following measurements:—

Length of the ventral valve	29 lines.
Width	30 „
Thickness of the valve	8 „

[1] Geol. of Russia and Ural Mountains, vol. ii, 1845.

[2] Beiträge zur Geognosie des Russischen Reiches, St. Petersburg, 1830.

Seventeen years later M. d'Orbigny proposed the term ORTHISINA for exactly the same shells;[1] nor does he allude to the Russian author, whose name *Pronites* or *Hemipronites*, might have saved the necessity of a fresh appellation.[2] M. d'Orbigny states that he is only acquainted with three species belonging to his section, viz., *O. anomala*, *O. Verneuili*, and *O. adscendens*, and seems impressed with a false idea as to the value of the temporary foramen,[3] which in middle-aged shells is rarely visible. I feel disposed to extend the limits of *Orthisina*, by admitting therein a number of so-called *Orthis*, with closed fissures, such as *O. plana*, *O. pelargonata*, *crenistria*, and other similar forms, which would not, I think, be properly placed in *Orthis* or *Strophomena*. The section *Orthisina* seems to connect the two last-named genera, and would be found convenient in arranging and separating a number of species which could not be united without destroying the clearly-defined characters of both *Orthis* and *Strophomena*.

Geol. range.—*Orthisina* first appeared in the lower Silurian period, and continued to be represented in the Devonian, Carboniferous, and Permian epochs, above which no authenticated species has been hitherto recorded.

Examples: *O. adscendens*, Pander, sp. = *excelsa*, id. *O. Verneuili*, Eichw., sp.; *O. anomala*, Schl., sp.; *O. plana*, Pand., sp.; *O. hemipronites*, V. Buch., sp.; *O. crenistrias*, Phil., sp.? *O. pelargonatus*, Schl., sp., &c.

Genus—STROPHOMENA (*Rafinesque*), *Blainville*, 1825.[4]

Type—S. RUGOSA, *Raf.*?[5] = S. PLANUMBONA or S. ALTERNATA. Int., Pl. VIII, figs. 157—175.

ANOMIA (part) of *Linnæus*.
PERIDIOLITHUS, *Hüpsch*.

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[1] Considérations Zoologiques et Géologiques sur les Brachiopodes, Comptes rendus de l'Académie des Sciences, Paris, 1847.—Ann. des Sciences Nat., vol. viii, pl. vii, fig. 30.—Paléont. Franç. Ter. Crétacés, vol. iv, p. 339.—Prodrome, vol. i, p. 16.

[2] I felt embarrassed as to what name to preserve, and therefore consulted several Palæontologists, among others, Messrs. Salter, Woodward, and Morris, who agreed that as Pander had assembled a number of different things in his sections, and applied to the same shells several generic names, without pointing out their characters; and as M. d'Orbigny's name *Orthisina* had already been adopted by several authors, it was advisable to retain it in preference to those of Pander.

[3] The presence or absence of the foramen is of comparative little generic valve, that character being common to other sections, although in this case differing both from *Strophomena*, *Terebratula*, and *Rhynchonella* by its position, the aperture being entirely excavated in the substance, and near the extremity of the deltidium, and not in the beak itself, as in many other genera.

[4] Nobody has hitherto produced the American author's description or date; but Blainville describes the genus *Strophomena* in his 'Manuel de Malacologie,' in 1825, "*Coquille équilatérale, reguliere, subéquivalve; ayant une valve plate, l'autre un peu excavée, articulation droite, transverse, offrant à droite et à gauche d'une subéchancrure médiane, un bourrelet peu considérable crénelé ou denté transversalement, aucun indice de support.*"

[5] No one seems to have clearly pointed out or identified with certainty *S. rugosa* of Raf.

TEREBRATULITES (part), *Schloth.*
STROPHOMENA, *Raf.*, *Blainville*, and other Authors.
LEPTÆNA, *Dalman*, and of the generality of Authors.
LEPTAGONIA, *M'Coy.*
ORTHIS (part) of *V. Buch.*
PRODUCTA (part), of *Phillips* and *Deshayes.*

Animal unknown; *shell* depressed, expanded, semicircular, sub-quadrate, transverse or elongated; external surface smooth, variously striated or costated. Hinge line straight, generally as long as the width of the shell; *dental* or *ventral* valve convex or concave; *socket* or *dorsal* valve following the curves of the other, the margin in some species being suddenly and abruptly bent down when the shell is half grown; *area* double, crenulated at its inner edges, and more developed in the dental valve; fissure in larger or ventral valve partly covered by a deltidium, the extremity of the beak entire, or perforated by a small circular aperture which became closed at a more advanced period of the animal's life. In the *socket valve*, the fissure is either partially covered by a deltidium, or entirely occupied by a projecting cardinal boss. In the interior of the *dental valve*, two widely-diverging teeth articulate with corresponding sockets in the other valves; the muscular impressions are more or less distinctly margined by a semicircular ridge continued from the base of the teeth, and curving on either side so as to produce a saucer-shaped depression of variable dimensions. The *cardinal* muscles fill on either side the anterior portion of this cavity; the pedicle muscles leave no definite scars, unless the external portions of the "cardinal muscular impressions" are due to them. The adductor lies close to a slightly elevated mesial ridge. In the interior of the *smaller* valve the cardinal process or boss is large and divided into two lobes, and not connate with the divergent socket ridges; to this process were no doubt affixed the cardinal muscles,. From this a slight mesial ridge runs down, and separates the two pairs of adductor scars, which are frequently bordered by prominent ridges; the vascular impressions consist of large primary vessels which run at once direct to the margin, following a somewhat radiate arrangement, or else the lateral trunks are greatly enlarged and reflected to surround the ovarian spaces.

Obs. Much has been written on the shells above described, and many have been the opinions entertained, and sub-divisions proposed, for Rafinesque's and Dalman's genera *Strophomena* and *Leptæna*.[1] Some authors have adopted one name in preference to the other for the same species, while a few would preserve both, but all are not agreed in what manner the division should be made. It will not be necessary to enter into the dis-

[1] *Petrefacta suecana*, in Kongl. Vet. Acad. Handl., 1828.

1. *Leptæna*, "sub-equivalve, flattened, with the margins compressed and bent, hinge line straight, very wide; foramen O.; one valve with two blunt teeth. First example, *L. rugosa*, His. Second, *L. depressa*, Sow. Dalman speaks of Leptæna, as equal to part of Sowerby's genus *Productus*, which he abolishes. In the supplement to the *Mineral Conchology*, Mr. James De Carle Sowerby adopted *Leptæna* as a substitute for *Productus!*

cussions that have taken place on this subject,[1] a few observations, however, may be admissible. No author seems to have as yet discovered *substantial characters* by which the shells placed in *Strophomena* or *Leptæna* can be generically divided; those hitherto proposed, as justly observed by Professor M'Coy; "*do not seem worthy of generic rank.*"

After a careful examination of a great number of species I agreed, with Mr. Salter, to maintain both *Strophomena* and *Leptæna* subject to certain limitations, but we could not prefix to this last *many* very important distinctive characters. STROPHOMENA would include all species agreeing with *S. planumbona, alternata, grandis, filosa, euglypha, funiculata, antiquata, pecten, expansa, depressa,* &c. LEPTÆNA we would typify by such forms as *L. transversalis, sericea, transversa, oblonga, Davidsoni, tenuicincta,* &c. These two genera thus formed are well distinguished by habit, but the distinctive characters rest chiefly on the form of the muscular impressions and cardinal process.

Professor King, on the other hand, is desirous of dividing the above-named shells into three sections or genera, observing that the external and internal characters of *L. alternata, depressa,* and *transversa,* or *transversalis,* are sufficiently distinct to admit of the names *Strophomena, Leptæna,* and *Plectambonites,*[2] being advantageously applied: thus he proposes to typify the first by *S. alternata.* "*Valves regularly plano-convex; foramen, when existing, partly edged by the deltidium, pallial vessels running at once almost direct, or in a somewhat radiate manner from the muscular impressions to the front*" (see Pl. VIII, fig. 160). *Leptæna,* he typifies by *L. depressa,* Dal.; "*Valves geniculated, wrinkled; umbone of the dental valve foraminated; pallial vessels running parallel with each other till they have reached to near the anterior region, where they sweep round submarginally on both sides, giving off a series of smaller vessels.*" But the learned Professor admits into his section *Strophomena,* shells essentially geniculated, such as *S. euglypha* and *imbrex;* and the

Fig. 37. Fig. 38.

Strophomena analoga.[3]
Interior of the ventral and dorsal valves.
a, ovarian spaces. e, foramen. t, teeth.

[1] Refer to Professor M'Coy's Synopsis of the Carb. Limest. Fossils of Ireland, p. 104, &c., 1844; and Brit. Pal. Foss. in the Woodw. Mus., p. 232, 1852.—Professor King's paper on the Palliobranchiata, 'Ann. and Mag. of Nat. Hist.,' vol. xviii, p. 36, 1846; and the same author's Monog. of English Permian Fossils, p. 103, &c., 1849.—Mr. Salter's Palæontological Appendix, in the 'Memoirs of the Geol. Survey of Gr. Britain,' vol. ii, pt. 1, p. 377, 1847.—Mr. Sharpe; Quart. Journal of the Geol. Soc., vol. iv, p. 178, 1848.—M. d'Orbigny; Pal. Fr. Ter. Crétacés, vol. iv, p. 335, 1847; and Prodrome, vol. i, 1849.—De Verneuil; Bull. de la Soc. Géol. de France, vol. v, May, 1848, &c.

[2] This section was proposed by Pander, in his work entitled 'Beiträge zur Geognosie des Russischen Reiches,' 1830, his types being *P. planissima, transversa, lata, imbrex, oblonga,* &c., figured in his pl. xix.

[3] These figures are reductions from those published in Professor King's 'Monograph of the Permian Fossils of England,' pl. xx, figs. 6, 7.

value of the character to be derived from the pattern of the vascular impressions is considerably reduced, from the positive fact of a species, *S. expansa*, Sow.,[1] presenting along with the hinge and general habit of *S. alternata*, an arrangement of the vessels more like *L. depressa* or *analoga*, which, with a slight modification, are reflected, as in the last-named species, to surround the ovarian spaces, &c. (Pl. VIII, fig. 162.) Mr. Salter and myself were of opinion that we might, perhaps, in the present state of our knowledge, divide the genus *Strophomena* into three sub-sections, thus :—

Sub-section 1. *S. alternata, planumbona, grandis, filosa, euglypha, funiculata*, &c.
2. *S. expansa* (the only species with certainty known.)
3. *S. depressa, analoga, Bouei*, &c. (*Leptagonia*, M'Coy).

But I think it will be preferable not to introduce these divisions until more is known of the pattern of the vascular impressions and other characters of the hitherto unexamined species, as well as of their general habit. The area in some forms, such as *S. latissima*, Bouch. ; *Naranjoana*, Vern., &c., has no deltidium or fissure, and yet the internal characters agree with other *Strophomenæ*.

Geol. range.—This genus contains some of the oldest forms of animal life, abounding in the lower and upper Silurian, Devonian, and Carboniferous periods, but it is not positively known above that epoch.

Examples: with the socket valve concave; *L. alternata, depressa, analoga, imbrex, Loveni ;* &c.
with the socket valve convex; *L. euglypha ; funiculata, antiquata, planoconvexa, planumbona, pecten, sulcata*, &c.

Genus?—LEPTÆNA, *Dalman*, 1827, restricted.

Type—L. TRANSVERSALIS, *Dal.* Int. Pl. VIII, figs. 176—185.

ANOMIA, *Linnæus* (part).

LEPTÆNA (part), of *Dalman*, 1827, as well as of the generality of Authors.

PLECTAMBONITES, *Pander*, 1830.

Animal unknown; *shell* involute, semicircular, transverse or elongated; surface smooth or variously striated; dental or ventral valve (always?) regularly convex; *socket valve* concave and following the curve of the other; area double, fissure in the dental valve partly covered by a deltidium; summit sometimes perforated by a small circular aperture; valves articulating by means of teeth and sockets; in the interior of the *dorsal valve* the socket ridges are largely developed, the cardinal process or boss small, multifid, and

[1] Mr. Salter called my attention to this remarkable species, figured by himself in the 'Silurian System,' pl. xx, fig. 14, and having borrowed the original specimen now in the Mus. of the Geol. Society, and compared it with other examples in the Mus. of Practical Geology, I was enabled to restore the entire impressions, incomplete from fracture in the original example.

connate with their bases; the muscular impressions left by the adductor are large, produced, and elongated, occupying more than two-thirds of the length of the valve, and bordered by well-defined ridges. In the interior of the *dental valve* the muscular scars are small, and not distinctly margined; the adductor lies close to a slight mesial ridge, while the cardinal muscles leave larger scars on either side; vascular impressions radiating.

Obs. On comparing with attention the shells above characterized with those forms we have admitted into *Strophomena*, such as *S. alternata* and *depressa*, the observer is struck by the great difference observable in the shape and position of the muscular impressions, especially in the interior of the socket valve: this character is constant, and essentially the same in *Lept. transversalis, sericea, oblonga, Davidsoni, tenuicincta, quinquecostata*, &c.; other differences likewise exist in the development of the socket ridges and cardinal process. It would, perhaps, therefore be advisable and convenient to retain for these species the term *Leptæna*, especially as one of Dalman's types is comprised in this section, and by so doing, the general opinion in favour of preserving the two names *Strophomena* and *Leptæna* is deferred to; in this view I am supported by Mr. Salter, who had long ago come to the same conclusion. Professor King admits the generic claim of this group, but would prefer the name *Plectambonites*, as he feels desirous of retaining that of *Leptæna* for such shells as *L. depressa*, and *L. analoga*, &c.; but we have already expressed under *Strophomena*, the objections to that arrangement. Some of the species in this group, (*L. Davidsoni, L. oblonga*, &c.) are likewise perforated by a small circular foramen, for the passage of a temporary pedicle, proving how unfounded were M. d'Orbigny's views when characterising *Strophomena* with a perforation, and *Leptæna* without one; but as the interior of a vast number of species of so called *Strophomena* and *Leptæna* are still unexamined, it would be premature to come to a *fixed* conclusion on the subject.

Geol. range.—Some of the shells composing this genus appeared for the first time in the oldest Silurian period, and continued with very similar shapes upwards and through the Lias, above which no examples have been hitherto observed.

Examples; L. transversalis, Dalman; *sericea*, J. Sow.; *oblonga*, Pand.; *Davidsoni*,[1] Ed. Deslongchamps; *quinquecostata*, M'Coy; *tenuicincta*, M'Coy; *transversa*, Pand.; *convexa*, Pand., &c.; *liasiana*, Bouch.; *Bouchardii*, Dav., &c.

Sub-Family ?—DAVIDSONIDÆ.

Animal unknown; shell fixed to marine bottoms (rocks, shells, and corals) by a portion of the dental or ventral valve; hinge line straight, with a more or less developed false area,

[1] The discovery of this remarkable species in the upper Lias of Normandy is due to Mr. Perier, of Caen, and has been described and illustrated in M. Eugene Deslongchamp's valuable paper on the Leptænæ and Thecideæ of the Lias. *L. Davidsoni* measures 10 lines in width, and bears the most striking resemblance in external shape to some Russian Silurian specimens of *L. transversa*.

and deltidium in the attached valve; no calcified supports for the arms, which were evidently fleshy and spirally coiled.

Obs. The place this genus should occupy in the classification, does not seem to have been quite satisfactorily established, I have therefore followed Professor King in constituting it for a small sub-family, whence it may be easily removed, should future discoveries require it to be admitted into any of those already established.

Genus—Davidsonia, *Bouchard*, 1849.

Type—D. Verneuili, *Bouch.* Int., Pl. VIII, figs. 186—193.

Thecidea (prisca), *Goldfuss*, MS. Mus. of Bonn.

Leptæna? *De Verneuil*, 1845.

Davidsonia, *Bouchard, De Koninck, King, Schnurr*, &c.

Shell transversely oval, with thick unequal valves, fixed to marine bodies by a portion of the surface of the ventral valve, filling outward irregularities, but not reproducing the same internally; the unattached portion of the dental valve rises abruptly, especially in front; area more or less defined, and divided by a convex triangular pseudo-deltidium, considerably notched at its inner margin; upper or socket valve thick, slightly convex or concave; external surface smooth and marked by concentric lines of growth which extend uninterruptedly over the rudimentary area. Valves articulating by means of strong teeth placed on either side at the base of the fissure close to the hinge line, and corresponding with sockets in the upper valve. In the interior of the *attached valve* a hollow is visible under the pseudo-deltidium, affording space for the cardinal muscular process of the other valve; between and below the dental projections are situated the muscular scars, which extend to about a third of the length of the shell; these consist of two deep oval impressions, probably left by the cardinal muscles, and divided by a broad flattened and sinuated mesial elevation, to which the adductor was possibly affixed; the greater portion of the interior is occupied by two conical elevations projecting more or less beyond the level of the valve; the lateral and frontal portions of these solid cones exhibit five or six semicircular or spiral projecting ridges, diminishing in surface and width as they approach the summit of the cone, but not distinctly extending over the portion facing the cardinal edge, which is covered to its extremity with the same minute indentures or punctures which are seen on those portions of the internal surface unoccupied by muscular scars; the cones are separated by a longitudinal furrow, or space, which blends with the raised border surrounding the interior of the valve. In the interior of the upper or dorsal valve, between the largely developed socket walls, and close to the hinge line, is situated a small cardinal process, under this the deep adductor impressions are seen lying in a semicircular

depression, in the anterior half of the thickened valve are excavated two conical hollows, which correspond to the cones of the attached valve, and like them are separated by a rounded mesial ridge, united near the front to the raised border which surrounds the valve.

Obs. M. de Verneuil was the first to draw attention to the shell above described, by publishing a figure of the lower valve of a specimen from the Eifel,[1] which he classed with doubt in *Leptæna*, adding, "*that the spiral arms were coiled five or six times on each other, and placed in the attached valve, so as to rise perpendicularly against the smaller one;*" the author having kindly presented me with one of his four examples, M. Bouchard founded on it the genus DAVIDSONIA,[2] for which compliment I feel greatly obliged to my old and distinguished friend. M. Bouchard clearly proved that the shell was not a *Leptæna*, but it must likewise be observed, that at the period above-mentioned only the lower valve was known, so that the description was naturally incomplete; but this blank was some time after filled up by M. de Koninck's fortunate discovery of two upper valves.[3]

Much difference of opinion has been expressed as to the nature of the various impressions visible in the interior of the shell, as well as to the systematic position of the genus. M. de Verneuil's original view of the massive cones has already been noticed. M. Bouchard believes that they were produced *by secretions deposited by the posterior adductor muscle*, while M. de Koninck sees in them nothing more than the *common thickening of certain portions of the valves* in other Brachiopoda, such as *Bouchardia rosea*, &c.; and Professor King states, *that he is "still in favour of these cones having been produced by labial processes."*[4]

Some authors believe that the arms could not have influenced the form of the shell; but the absence of such impressions in recent forms, is no argument against the possibility of such occurring in some of those extinct species, where, as in *Davidsonia*, so small a space remains for the animal;[5] nor do I think it possible that the labial appendages could have occupied any other space than the small one existing between the cones; and that the mantle, by pressing on the free spiral arms, retained some impressions of their coils, which were transmitted to the shell it was secreting: and this view appears the more probable, since the vascular trunks and veins existing on the mantle, were likewise impressed on the outer sides of the cones as well as on other portions

Fig. 39.

Section of Davidsonia, *in the collection of M. de Koninck. The space left white between the valves is the only one occupied by the animal; f. is the portion attached.*

[1] Geol. of Russia and the Ural Mountains, vol. ii, p. 227, pl. xv, fig. 9, 1845.

[2] Mémoir sur un Nouveau genre de Brachiopode, &c., 'Annales des Sciences Nat.,' vol. xii, p. 84, 1849.

[3] Notice sur le genre *Davidsonia*, 'An. de la Soc. Royale des Sciences de Liege,' vol. viii, p. 149, 1852. These valves are now in the British Museum. [4] Monograph of the Permian Fossils, p. 151, 1849.

[5] Similar impressions occur in certain examples of *Productus* and *Strophomena*, and which may be attributed to the same cause.

of the shell.[1] M. Bouchard is of opinion that *Davidsonia* forms the passage from the articulated to the unarticulated genera. M. de Koninck considers it to bear more analogy to *Thecidea* than to any other,[2] while Professor King and Mr. Woodward would place the genus in the family *Strophomenidæ*.

Geol. range.—In our present knowledge the genus is limited to the Devonian epoch. It occurs both at Chimay, and in the Eifel; in that horizon characterised by the *Calceola sandalina*.

Examples: *D. Verneuili*, Bouch.; *D. Bouchardiana*, De Koninck.

Family—PRODUCTIDÆ.

Animal unknown; *Shell* entirely free, or attached to marine bottoms by the substance of the beak; valves either regularly articulated or kept in place by muscular action; no calcified supports for the oral appendages, which were no doubt fleshy and spirally rolled.

Obs. We have admitted into this family the following genera: *Chonetes*, *Strophalosia*, *Aulosteges* and *Productus*, on account of the natural and intimate relation they bear to each other, as may be better understood by a glance at their respective figures (Pls. VIII and IX.) In all we perceive the same dispositions of the muscular system,[3] the same reniform impressions (supposed to be vascular?) and the same elevation on each side of the cardinal ridge (marked g¹ in Pl. IX, fig. 214, 219, &c.) In all, the surface of the valves is ornamented by tubular spines, which only vary in position and abundance. Professor M'Coy removes *Chonetes*, *Strophalosia*, and *Aulosteges* from the Productidæ,[4] and places them among the Strophomenidæ or Leptænidæ; but we regret not being

[1] M. Deshayes, Professor King, and Mr. Woodward, also believe that the form of the cones is due to the influence of the free arms upon the mantle lining the inner surface of the shell. M. de Koninck was correct in stating that the pallial vessels had left impressions on the outer sides of the cones and margins of the shell; but I was further able to trace the principal vascular trunks, from their origin between the muscles to near the front of the shell, where sweeping sub-marginally round both sides of the mantle they give off bifurcated veins, which have left impressions on the frontal and lateral margins of the cones, in a somewhat similar manner to what we find so well illustrated in Professor King's figures of *Stroph. analoga* ('Mon. of English Permian Fossils,' pl. xx, figs. 6 and 7).

[2] I admit, with M. de Koninck, that the external shape of *Davidsonia* is very similar to that of certain *Thecidia*, such as *Th. Moorei* and *Bouchardii*, but as the Belgian author justly observes, the internal dispositions are very different from those seen in any species of Defrance's genus *Thecidium*.

[3] Professor M'Coy is mistaken when he states that no traces of the *dendritic* muscular impressions are visible in *Strophalosia* or *Aulosteges*:—I have distinctly observed them in both. I must also confess I see a great difference between the reniform impressions of *Productus Strophalosia*, &c., and the vascular system of *Leptæna transversalis*.

[4] British Pal. Fossils in the Mus. of Cambridge, p. 387, 1852.

able to admit the conclusions arrived at by the learned Professor; and, on the contrary, firmly believe that the four above-mentioned genera are not only intimately related, but even lead me to *doubt* whether we are authorised in admitting as many as four genera.[1] None of the characters above described are found among the *Strophomenidæ*, where both the muscular and vascular system is essentially different; and the only similarity appears to consist in the presence in some of the Productidæ, of an area and pseudo-deltidium. The character of the area is essentially similar in *Chonetes*, *Strophalosia*, and *Aulosteges*, still the first two have a distinctly articulated hinge, while the last (*Aulosteges*), whose area and deltidium are far more developed than in the other two, is unarticulated, and thus intimately connect Strophalosia with Productus.

Genus—Chonetes, *Fischer*, 1837.

Type—C. sarcinulata, *Schl.*, sp. Int., Pl. VIII, figs. 198—202.

Pectinites, *Lister*.
Pectunculus, *Volkmann*.
Pectunculites, *Walch*.
Pecten, *Ure*.
Hysterolites et Terebratulites, sp., *V. Schloth*.
Productus, sp., *J. de Sow.*, *V. Buch*.
Orthis? (part), *Dalman*, *Goldfuss*, and of many Authors.
Leptæna (part), *V. Buch*, *J. Sow.*, *M'Coy*, &c.
Spirifera (part), *Phillips*.
Chonetes, *Fischer*, *De Koninck*, *De Verneuil*, and the generality of Authors.
Strophomena, sp., *J. Hall*, &c.
Delthyris, sp., *Fahrenkohl*.

Shell inequivalve, compressed, transversely semicircular, with a straight hinge line, commonly as long as the width of the shell, or prolonged in the shape of auricular expansions; *dental valve* convex, depressed towards the cardinal edge; *socket valve* always concave, following the curves of the other; area distinct, almost equal in both valves, or larger and more produced in the dental one; the upper edge of the area in the larger valve is acute, and provided with a row of delicate spinose hollow tubes, varying in number in different species, and becoming gradually longer as they recede from the extremity of the beak, diverging obliquely from the hinge line; fissure covered by a pseudo-deltidium. In the *socket valve* the opening is entirely filled up by a projecting bifid or trifid cardinal process; surface ornamented with minute, longitudinal, dichotomised, or intercalated striæ, rarely largely plaited, but transversely marked by concentric lines of growth.

Internally, the valves articulate by means of teeth placed at the sides of the fissure of the

[1] M. de Koninck admits only two genera in the family: viz., 1, *Chonetes*; 2, *Productus*, which last includes *Strophalosia*, King, and *Aulosteges*, Helm.

dental valve, and corresponding sockets excavated on each side of the cardinal prominence already described. In the dental valve, a small longitudinal ridge divides the muscular impressions situated on either side, the cardinal muscles probably occupied the greatest space, the adductor lying on either side close to the mesial ridge. In the *socket valve* a blunt medio-longitudinal ridge divides the quadruple impressions of the adductor muscle, which forms on either side two oval scars from between which (in some specimens) two short *vascular impressions* proceed in an outward oblique direction, when turning backwards and inwards, they terminate at some distance from their origin. The interior of the valves is covered with minute granulous asperities, arranged in longitudinal lines; *animal* unknown, probably free or attached in the young by fibres issuing from the fissure.

Obs. In 1837, Fischer de Waldheim proposed the genus *chonetes*,[1] but did not characterise it sufficiently; and it was only after the publications of M. de Koninck[2] and De Vernueil,[3] that its value became known, and the appellation generally used. Several authors have remarked that the shells composing this section bear affinities, both to *Productus* and *Leptæna*. Professor M'Coy, in 1852,[4] makes *Chonetes* a sub-section of *Leptæna*. The outer resemblance it bears to many of the species of the last-named genus is obvious; but internally there exist differences which remove it from the *Strophomenidæ*, and unite it by family ties to the *Productidæ*, and in particular to *Strophalosia*: these are the disposition of its quadruple adductor scars and the *reniform vascular impressions*, which I was so fortunate as to discover in a specimen from Néhou (Pl. VIII, fig. 200), and although the latter character is unobservable or indistinctly marked in the generality of *Chonetes*, I have been able to trace its existence in several species. *Chonetes* also possesses the *double area*, *articulated hinge*, and *tubular spines* of the *Productidæ*, and although the last character cannot be claimed as of generic importance, it is at any rate common to all the *Productidæ*, and wanting in the *Strophomenidæ*.

Chonetes should therefore be placed first or last among the *Productidæ*, and near to the *Strophomenidæ*, as it is a genus or sub-genus which in a measure links the two families together.

We must refer our readers, for detailed descriptions, &c. to the excellent monograph on this genus, published in 1847, by M. de Koninck: the occurrence of spines only on the outer edge of the area of the dental valve, distinguishes the species of this section from those of the other *Productidæ*, a circumstance of great convenience in the present case.

Geol. range.—*Chonetes* first appeared in the lower Silurian age, and continued through

[1] Oryctographie du Gouv. de Moscow, p. 134.

[2] Description des Anim. Foss. du Terrain Carb. de Belgique, 1843.

[3] Russia and Ural Mountains, vol. ii, 1845.

[4] British Pal. Fossils, 1852. American authors have often erroneously placed *Chonetes* among their *Strophomenidæ*.

the Devonian period, attaining its specific maximum during the Carboniferous epoch, above which no authenticated example has been yet recorded.

Examples: C. striatella, sp., Dalman.; *comoides*, J. Sow.; *concentrica*, De Kon.; *papilionacea*, Phil.; *Dalmaniana*, De Kon.; *sulcata*, M'Coy; *variolata*, D'Orb.; *armata*, Bouch.; *convoluta*, Phil.; *Verneuili*, Bar.; *Buchiana*, De Kon.; &c.

Genus—STROPHALOSIA, *King*, 1844.

Type—S. EXCAVATA, *Geinitz*, sp. Int., Pl. VIII, figs. 203—211.

SPONDYLUS (GOLDFUSSI), *Münster*, 1839.
ORTHIS (EXCAVATA), *Geinitz*, 1842.
STROPHALOSIA (=LEPTÆNALOSIA), *King*, 1844; *M'Coy*, &c.
PRODUCTUS, *De Verneuil*, *De Koninck*, and the generality of Authors.
ORTHOTHRIX, *Geinitz*, 1848.

Shell variable in shape, more or less circular, transverse or elongated, larger or dental valve convex, smaller one concave and following the curves of the other; surface ornamented by scattered tubular spines; beak often irregular, having been affixed by its substance to submarine objects; a small well-defined area in both valves, divided by a pseudo-deltidium: hinge-line straight; valves *articulated* by teeth and sockets, the former situated on each side of the base of the deltidium of the larger valve, and the latter on both sides of a cardinal muscular process of the socket valve. Internally, a longitudinal raised ridge extends from the cardinal process to about half the length of the valve, on either side of which is seen a small ovate raised muscular scar: the reniform impressions are rather large, their prominent outer edges issue from between the adductor scars, gradually arch forwards and outwards on each side, then turning backwards for about half their length, and finally run inwards horizontally to meet each other near the extremity of the mesial septum.

Obs. In 1844, Professor King proposed to separate from *Productus* certain shells possessing a well developed condyloid *hinge*, *area*, and *deltidium*, to which he applied the term *Strophalosia*.[1] This view has been sanctioned by some, but rejected by others who did not consider the distinctive characters sufficient to warrant the establishment of another genus.[2] About two or more years after the publication of Professor King's views, Dr. Geinitz proposed the generic appellation *Orthothrix*[3] for the same shells already known by that of *Strophalosia*. For a long time, I agreed with my friend M. de Koninck in resisting the establishment of this section, but after minute comparisons of the shells in question, aided by the kind assistance of Professor King, I must admit the existence of some grounds for establishing a separate group or sub-

[1] See Annals and Mag. of Nat. Hist., vol. xviii, p. 92, 1846; and Mon. of English Per. Foss., 1849.
[2] See De Koninck; Monographie des Genres Productus et Chonetes, p. 10, 1847.
[3] Die Vers. der Zechsteingebirges, &c., Dresden, 1848.

genus; the chief points of difference appear to consist—first, in the strongly articulated hinge of *Strophalosia*, while no *teeth* or *sockets* have yet been noticed in any true *Productus*, (such as *P. semireticulatus, longispinus, giganteus, horridus, &c.*,) where the valves are entirely kept in place by muscular action: the cardinal process or boss so often most improperly termed a tooth was simply a point of attachment for the cardinal muscle, a view clearly pointed out by Professor King, and which I have been able to verify in many recent forms of other genera. Secondly, by the presence of a well defined double area and pseudo-deltidium, of which scarcely any trace exists in true *Productæ*.[1] Internally, the muscular scars and reniform impressions seem also to offer some small differences, but preserve the essential characters of *Productus*.

Geol. range.—As far as our present knowledge goes, this genus first appeared in the Devonian period, was sparingly represented in the Carboniferous epoch, and attained its greatest numerical development in the Permian age, above which no authenticated example has been yet discovered.

Examples: St. Goldfussi, Munst., sp.; *S. Morrisiana*, and *Gerardi*, King; *productoides*, Murch., sp.; *Buchiana*, De Kon., sp.; ? *parva*, King; ? *subaculeatas*, Murch.;[2] &c.

Sub-Section—Aulosteges, *Helmersen*, 1847.

Type—A. Wangenheimi, *De Vern.*, sp. = A. variabilis, *Helm.* Int., Pl. IX, figs. 212—216.

Orthis, sp., *De Verneuil*, 1845.

Animal unknown; *shell* of an irregular pentagonal shape, with its larger or ventral valve, by far the most convex; beak produced, and generally twisted either to the one or the other side, and furnished with a well defined triangular area, longitudinally interrupted by a pseudo-deltidium not quite reaching to the hinge line, which is straight and not provided with articulating teeth; smaller or dorsal valve slightly convex at the umbo, depressed or concave laterally; cardinal edge more or less developed; surface of valves ornamented by a multitude of short tubular spires. In the interior of smaller valve a large and produced trifid cardinal process extends under a portion of the beak and deltidium, filling up the uncovered portion of the fissure, and serving as a point of attachment to the cardinal muscle; under this process a longitudinal mesial ridge extends nearly to the margin, and on either side are placed the elongated

[1] M. de Koninck states that an *area* is at times observable in some examples of *Prod. giganteus* and *punctatus*; but Professor King considers this appearance more deceptive than real, and only occasioned by a strongly developed cardinal edge or margin; the presence of a largely developed area and unarticulated hinge in *Aulosteges* connects *Strophalosia* with *Productus*.

[2] This species is placed by Professor King in *Strophalosia*; and it is worthy of notice, that M. Bouchard had described the articulated *hinge, area,* and *cardinal process,* in a paper on this species, in the 'Ann. des Sciences Nat.,' 1842.

ramified adductor scars; the reniform impressions, after dividing the above-named muscle, extend by an outward oblique curve to near the margin, when turning abruptly backwards and inwards, terminate at some distance from their origin. Under the adductor, more towards the centre of the valve, exist two elevations (perhaps, brachial eminences).

Obs. In 1847, Colonel Helmersen proposed the genus AULOSTEGES[1] for a remarkable shell abundantly found in the Permian Limestones of Mount Grebeni, in Russia, and described by M. de Verneuil, under the name of *Orthis Wangenheimi*,[2] and which the Russian author considered distinct from both *Productus* and *Strophalosia* of King. In outward aspect it differs from *Productus* by its remarkable area and *pseudo-deltidium*, recalling certain shapes of *Orthisina*, but internally, the muscular scars, cardinal process, and reniform impressions are essentially like those of *Productus*, varying but little in their position and details. According to Professor King's present views, *Aulosteges* is a link connecting *Productus* and *Strophalosia*, but it seems to me, that if this shell is to be separated from either of those genera, it can only claim a *sub-generic* rank; its animal must have been very similar to that of *Productus*.

Geo. range.—Hitherto only one species has been discovered, which belongs to the Permian age.[3]

Genus—PRODUCTUS, *Sowerby*, 1814.

Type—P. MARTINI, *Sow.*, or SEMIRETICULATUS, *Martin*, sp.[4] Int., Pl. IX, figs. 217–223.

GRYPHITES, sp., *Hoppe, Walch., Schlotheim*, &c.
ANOMIA, *Da Costa, Chemnitz.*
PYXIS, sp., *Chemnitz.*
ANOMIÆ ECHINATÆ et CONCHÆ PILOSÆ, *Ure.*
ANOMITES, *Martin, Schloth.* (part).
ARCA, sp., *Bruguière.*
TRIGONIA, sp., *Parkinson.*
PRODUCTUS, *Sowerby, Fleming, Deshayes, De Verneuil, V. Buch, De Koninck, D'Orbigny, King*, and of the generality of Authors.[5]
TRIDACNA, sp., *Lamarck.*
TEREBRATULA (part), *De Blainville, Rang.*
PROTONIA, *Link.*
ARBUSCULITES, *Murray, Teste, Bronn.*
LEPTÆNA, *Dalman* (part), *Fischer de Waldheim, Goldfuss, J. de C. Sowerby, Phillips*, &c.

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[1] Bull. Phys. Math. de St. Petersburgh, vol. vi, No. 9.

[2] Geol. of Russia and Ural Mountains, vol. ii, pl. xi, fig. 5, 1845.

[3] Professor King informs me that his *Productus umbonillatus* may require to be placed in the sub-genus *Aulosteges*.

[4] According to M. de Koninck, *Productus Martini*, Sow., would be a synonyme of *Anomites semireticulatus* of Martin.

[5] Pander places in PRODUCTUS shells we consider to belong to the genus *Leptæna* and *Orthis*.

Mytilus, sp., *Fischer.*
Producta, *Conybeare, Phillips, Kœnig, J. de C. Sow., M'Coy.*
Strophomena (part), *Bronn* (not *Rafinesque*).
Pinna, sp., *Phillips.*
Pecten, sp., *Eichwald.*
Lima, sp., *V. Buch.*

Shell variable in shape, inequivalve, transverse or elongated, furnished with lateral auricular expansions; *larger* or *ventral valve* regularly convex, geniculated, or perpendicularly incurved; hinge line straight, commonly shorter than the width of the shell; area very narrow, or no true area, but the cardinal edge considerably thickened; beak incurved. *Smaller* or *dorsal valve* concave, following the curves of the other valve. Exterior variously costated or striated, sometimes decussated by concentric lines of growth; from the striæ arise innumerable small closely packed tubular spines, especially abundant on the auricular expansions; in other species they are few in number, large, strong, and irregularly scattered over the surface, or arranged in regular or irregular rows near the cardinal edge; valves unarticulated, probably kept in place by the fibrous membranes and powerful muscular system of the animal.

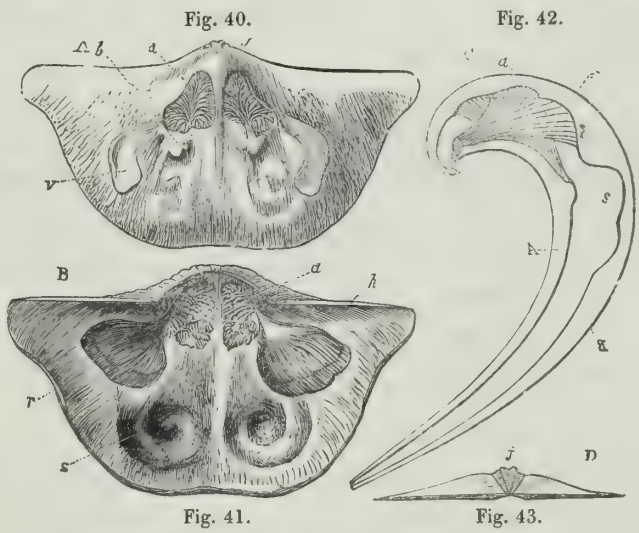
In the interior of the *larger valve* a narrow mesial ridge separates the two elongated ramified muscular scars left by the adductors? (hepatic impressions of V. Buch); immediately under, but outside these, are seen other two very deep longitudinally striated, subquadrate impressions, probably formed by the cardinal muscles, and more or less widely separated by a mesial elevation or crest, and lower down more towards the centre of the shell two other deep concave sub-spiral depressions are visible,[1] all the remaining inner surface of the larger valve not occupied by the muscular scars is indented by a multitude of small depressions, increasing in number under the auricles; in the centre of the hinge line of the *smaller valve*, a prominent trifid cardinal process afforded attachment to the cardinal muscles, under this a narrow longitudinal ridge extends to more than half the length of the valve, and becoming more elevated towards its extremity; on either side, are seen the ramified scars left by the adductors, and corresponding to those situated in a similar position in the other valve; each scar is double, the two portions being separated by the commencement of the great vascular trunks (see Pl. IX, f. 219). Outside, and in front of the muscular scars, are two elongated or reniform impressions; their surface is smooth, and they are bounded by ridges, which, after dividing the adductors proceed in an outward oblique or almost horizontal direction, when turning abruptly backwards they terminate at a short distance from their origin; between the vascular impressions, and close to the muscular scars, exist two prominences, one on each side of the cardinal ridge;[2] the internal surface of the smaller valve is covered with innu-

[1] Supposed by V. Buch, De Koninck, King, and others, as intended to afford space for spiral or labial appendages.

[2] These are supposed to indicate the origins of the spiral arms; in which case *Productus* differs from

merable produced tubercles protruding often in the shape of short spines, especially visible near the marginal portions of the shell; no calcified supports for the arms, which were probably small and vertically coiled.

Obs. Although much has been published on this extensive genus by several learned Palæontologists, authors do not seem to coincide in the interpretation to be given to some of the impressions observable on its internal surface. Professor King has endeavoured to restore the muscular system; but from an attentive examination of the identical specimens on which the learned Professor conducted his examinations, as well as others in the Cambridge University Museum, the cabinet of Mr. Tate, &c., neither Mr. Woodward nor myself were able to recognise in a distinct manner more than the scars left by the cardinal and adductor muscle,[1] as seen in the annexed woodcut. A variety of opinions have been expressed, as to the manner in which the animal of this genus lived; some believe that the shell was affixed by its spines, others by the extremity of the beak of larger valve, or suspended by muscular fibres issuing from the margins of the valve![2] M. d'Orbigny supposes that the animal lived lying on soft bottoms, with its smaller valve uppermost, in a similar manner to *Oysters*, *Scallops*, and *Spondylus striatus*, in which the lamellæ and spines served to retain the animal in a fixed position; but M. de Koninck objects that these spines are often so long and so delicate, as to make one believe they would be fractured under such conditions. The remarkable tubular expansion of the larger valve in *Prod. proboscideus* led the last-named author to suppose that out of its extremity passed the muscular fibres of attachment; M. d'Orbigny, on the contrary, states it to be his belief that the prolongation was due to malformation produced by accidental circumstances, connected with the supposed constrained position in which the animal lived, having forced the mantle to



Productus giganteus (from Mr. Woodward's drawings).

Fig. 40. *Interior of dorsal valve.*—41. *Interior of ventral valve, with the umbo removed.*—42. *Ideal section of both valves.*—43. *Hinge-line of dorsal valve:* j, *cardinal process;* a, *adductor;* r, *cardinal muscles;* s, *hollows occupied by spiral arms;* v, *reniform impressions;* b, *brachial processes?;* h, *hinge-area.*

Terebratula, and agrees with *Crania* in *three* important particulars, viz. the absence of a hinge, the simplicity of the vascular impressions, and the shifting of the processes for the attachment of the arms, from the hinge-margin to the centre of the shell.

[1] Professor King states that he found impressions of pedicle muscles, and indeed that he was able to trace all the muscular scars observable in Terebratula. ('A Monograph of English Permian Fossils.')

[2] See Geinitz' 'Deutsch. Zechst.,' t. vi, f. 1.

prolong its edges so as to reach the surface of the sea bed: in the locality in which this form is found, a vast number of other species of the genus occur, which do not present this peculiarity, so that we must regard the structure as *normal*, although M. d'Orbigny's explanation of its function is probably correct. The thickness of the shell in many species is very considerable; but we must refer our reader for more ample details to the most valuable monograph of this genus, published in 1847, by M. de Koninck, as well as to several publications on the same subject, by Professor King, M. de Verneuil, and others, in which a multitude of details will be found which my limited space will not admit of mentioning here. Various authors have proposed to arrange the numerous species belonging to this genus into several groups, chiefly founded on the manner in which the shell was ornamented.

Geol. range.—*Productus* does not seem to have had so extensive a vertical range as either *Strophomena* or *Orthis*, being restricted to the *Devonian*, *Carboniferous*, and *Permian* periods, and specifically rare in the first and last of these.[1]

Examples: *P. giganteus*, Martin, sp.; *latissimus*, Sow.; *striatus*, Fischer, sp.; *cora*, D'Orb.; *Erminius*, De Kon.; *Medusa*, De Kon.; *semireticulatus*, Martin, sp.; *costatus*, J. Sow.; *Flemingii*, Sow.; *spinulosus*, Sow.; *scabriculus*, Martin, sp.; *fimbriatus*, Sow.; *horridus*, J. Sow.; *tessellatus*, De Kon.; *undatus*, Def.; *proboscideus*, De Vern.; *hemisphæricus*, Kutorga; *porrectus*, Kut., &c. &c.

Family—CALCEOLIDÆ.

Animal unknown. *Shell* probably free, valves not articulated; ventral valve pyramidal, with a large, flat, triangular area; dorsal valve flat, semicircular, with a straight hinge-line, a small cardinal process, and two lateral groups of small apophysary (?) ridges; no foramen or muscular or vascular impressions.

Obs. Only one *genus* is known, and so anomalous in its characters that its true place in the class is far from being definitely settled.

Genus—Calceola, *Lamarck*, 1809.[2]

Type—C. sandalina, *Linn.*, *Gmel.*, sp., p. 3349. Int., Pl. IX, figs. 294—298.

Anomia (part), of *Gmelin*, &c.
Sandaliolithes, *Schröter*.
Conchyta Juliacensis, Crepites, Sandalites, Crepidiolithus, of *Hupsch*.
Turbinoliæ, sp., *Hisinger*.
Calceola, *Lamarck*, and of the generality of Authors.

[1] Some doubt seems still to exist if the genus was truly represented in the Silurian period. Professor King believes, from the dispositions of the vascular system, that my so-called *P. Twamleyi* belongs to the genus *Leptæna*.

[2] Système des Anim. sans Vert., p. 139; Hist. des Anim. sans Vert., vol. vi, p. 234, 1819.

Shell of a triangular shape, with very unequal valves; *larger valve* sub-pyramidal; beak acute, bent backwards; hinge line straight; area large, triangular, slightly curved, and divided by a long narrow mesial elevation, extending from the apex to the cardinal edge, and longitudinally depressed along its centre; *smaller valve* semicircular, operculiform, slightly convex or almost flat, with a narrow sub-parallel triangular area. Exterior smooth, or encircled by concentric lines of growth, passing uninterruptedly over the area; hinge line crenulated. The cavity for the animal is small in proportion to the dimensions of the shell. The interior of the *smaller valve* is divided by a slightly elevated mesial ridge or septum, terminating at the hinge line in a small cardinal process, which is hollowed in the middle; from the whole extent of the hinge line a number of punctate striæ radiate to the margin; on each side, close to the hinge-line, in the vicinity of the cardinal angles, is a series of short parallel unequal elevated ridges. In the interior of the *larger valve* a corresponding series of punctate striæ proceeds from the whole margin, and converge towards the bottom or cavity of the shell, but becoming more elevated and produced at the cardinal edge, where they form unequal asperities; in the centre, and near the hinge line, a larger rounded projection (corresponding to the first described in the other valve) extends to the bottom of the shell, in the shape of a narrow mesial depression.

Obs. Of all the genera among the Brachiopoda, *Calceola* seems the most abnormal; no one has been able to point out the probable structure of the animal, nor has its true position in the class been yet satisfactorily ascertained. One would have imagined that such a ponderous shell would have been provided with a powerful muscular system, still no traces of it have been observed in the interior of the valves; and so great was the amount of calcareous matter deposited internally, that in many examples hardly any free space remained to lodge the animal. Some authors have expressed doubts whether this genus should be ranked among the Brachiopoda; Cuvier, in his 'Règne Animal,' classes it with the *Oysters;* Lamarck, and a few other Conchologists, place it in the family of *Rudistes*, whence it was removed by M. Deshayes and Goldfuss; it is now generally admitted to belong to the Palliobranchiata. The type of the genus, *Calceola sandalina*, has been long known under various appellations.[1]

Its *Geol. range* is confined to the Devonian period. Only one well-authenticated species has been discovered.[2]

Example: C. sandalina, Linn., Gmel., sp.

[1] Hüpsch described and figured it in 1768, and Beuth, in 1776. Goldfuss has likewise published excellent illustrations of the species, in his 'Petrefacten Musei Universalis,' pl. clxi.

[2] M. de Koninck has lately stated in the seventh volume of the 'Ann. des Sciences Royales of Liege,' that the so-called *Calceola Dumontiana* does not possess the characters of that genus, and even doubts whether the species belongs to the class; he terms it *Hypodema*.

Family—CRANIADÆ.

Animal fixed to marine bottoms by the substance of the shell of its lower or ventral valve; arms fleshy, and spirally coiled; no hinge or articulating processes; upper or dorsal valve patelliform.

Obs. This family contains only one genus, *Crania*.

Genus—Crania, *Retzius*, 1781.

Type—C. Brattenburgensis, *Stoboeus*, sp. Int., Pl. IX, figs. 299—247.

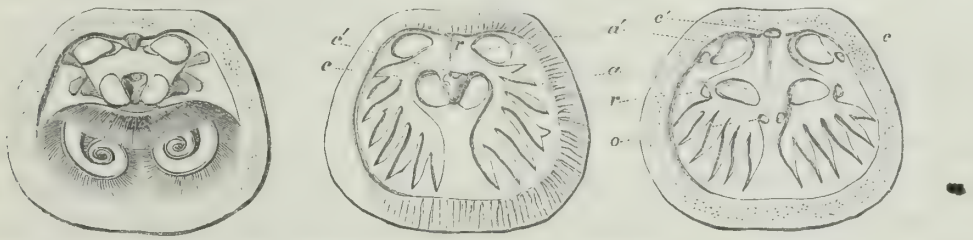
Numulus, *Stoboeus*, 1732.
Anomites (part), of *Linnæus*, 1768.
Ostracites, *Beuth*, 1776.
Patella (anomala), *Müller*, 1776.
Crania, *Retzius*, 1781, and of the generality of Authors.
Orbicula (anomala), *Cuvier*, 1798; *Lamarck*.
Craniolites, *Schloth*.
Criopus (for the Animal), *Poli*, 1791.
Pseudo-crania, *M'Coy*, 1852.
Spondylobus, *M'Coy*, idem.

Shell variable in shape, inequivalve, circular, subquadrate, transverse or elongated, partially or extensively attached by the substance of its lower or ventral valve; rarely free; *upper* or *dorsal valve* more or less conical, vertex subcentral; no articulated hinge or ligament, the valves being kept in place by the action of four muscles, which pass in a somewhat oblique manner from one valve to the other; the *attached* or *ventral valve* is generally the thickest, with or without a straight more or less produced beak, and false area. External surface smooth, spiny, or variously ornamented by radiating costæ or foliaceous expansions; the concentric lines of growth passing uninterruptedly over the valves and area;[1] structure calcareous and tubular. In the interior, four principal

[1] The *false area* of certain species of *Crania* is clearly described by M. Bouchard, in the twelfth volume of the 'An. des Sciences Nat.,' p. 87, 1849, as follows:—"Chez la *Crania antiqua* les espèces voisines (et la *Davidsonia*) . . . . . ce que l'on nomme *area* n'en est pas une, ce n'est que le résultat d'un accroissement général, et pour ainsi dire oblique, de tout le corps de la valve, qui forme une sorte de *crochet* ou *talon*, sur lequel passent les mêmes lignes d'accroissement qui, se continuant, font tout le tour de la valve. Cet accroissement est donc tout à fait circulaire et unique pour toutes les parties de la valve: mais il offre cette particularité, qui forme son obliquité, c'est que chaque lame est indiquée sur la face supérieure du talon par une simple strie qui, en s'en éloignant, s'élargit de chaque côté, de manière à atteindre une largeur de près de 1 millimètre vers le bord postérieur. Ce *talon* ensuite n'est jamais creux: il est au contraire massif et calcaire: donc aucune partie de l'animal n'a pu s'y loger. Enfin, la marche de cet accroissement est absolument semblable à celui des *Huitres*, et les *talons* des uns et des autres sont exactement de la même structure."

scars formed by the adductor muscles are observable. The anterior pair are approximate, and placed close to the centre, behind which a prominence is sometimes visible in the ventral valve. The posterior pair are situate near the cardinal edge, and are widely separated. The muscular impressions of the attached valve are sometimes slightly convex, at others deeply excavated; those of the dorsal valve are convex, the centre pair sometimes developing very prominent apophyses. (See Part II, Pl. I, f. 2 *b*.) The interior of the attached valve is surrounded by a raised and thickened border, exhibiting the tubular shell-structure in a conspicuous manner. The disk of each valve exhibits more or less distinct impressions of the vascular system, which is simply digitated.

Fig. 44. Fig. 45. Fig. 46.



Crania anomala, Müll., from specimens dredged off Zetland, and communicated by J. S. Bowerbank, Esq. (From drawings made by Mr. Woodward.)

Fig. 44. *Upper valve with the animal; the mantle-lobe has been removed, to show the spiral arms and the muscles. The small central depression is caused by the process* (c) *of the lower valve. The mouth is concealed by the overhanging fringe of cirri.*

Fig. 45. *Lower* (ventral) *valve.*

Fig. 46. *Upper* (dorsal) *valve. Explanation of the letters:* a, *anterior adductor impression;* a', *posterior adductors;* c, c, *points of attachment of the protractor muscles;* c', c', *impressions of the cardinal muscle;* r, r, *points of attachment of the retractor muscles.*

The valves of *Crania* appear to have been opened by the action of sliding muscles, as described by Professor Owen, in *Discina;* those which advance the dorsal valve (*protractor* muscles), are aided by a single small muscle in the median line, answering exactly to the cardinal muscle of *Terebratula*. The pair of muscles which bring the free valve back to its place (*retractors*), are attached outside the anterior adductors of the free valve, and (apparently) to a point between the posterior adductors in the fixed valve (like their equivalents, in *Discina*, according to Owen). The two small impressions in the centre of the dorsal valve (fig. 46) are probably caused by the attachment of the muscles of the spiral arms. The labial arms are thick, fleshy, and spirally coiled; the volutions are few, and directed, vertically, towards the cavity of the dorsal valve, as in *Rhynchonella* and *Davidsonia*, and unlike *Producta* and *Discina*. The mantle lobes of *Crania* extend to the edges of the valves, and adhere closely, as in *Thecidium;* their margins are plain and thin.

Obs. Stoboeus appears to be the first author who figured and described a species belonging to this genus, under the names of *Numulus Brattenburgensis* and *minor*,[1] and

[1] Stroboeus; Diss. Epist. Lund., 1732, and *Opuscula*, &c.

shortly after (1768,) Linnæus changed the term to *Anomites craniolaris*. The genus was founded by Retzius,[1] in 1781, on the first of Stoboeus's types; Poli, in 1791, figured the animal of a recent species, which he termed *Criopus*;[2] but Müller had before him, in 1776 and 1781, described another recent form, picked up on the coast of Denmark, under the name of *Patella anomala*.[3] This shell has proved the subject of lamentable confusion; Cuvier, believing it distinct from the *Crania* of Retzius, proposed for it the generic appellation *Orbicula*,[4] a name which must unavoidably be expunged from the nomenclature and placed among the synonymes of *Crania*, since the so-called *Patella anomala* undoubtedly belongs to the last-mentioned genus.[5] Professors King[6] and M'Coy[7] have proposed to split the genus *Crania* into several sections, but I do not consider the points brought forward of sufficient value. The first of these authors limits the genus *Crania* to species similar to *C. Ignabergensis*,[8] which are only attached by a small portion of their lower valve, and proposes the term *Criopus* for those (*C. turbinatus, Parisiensis, &c.*) affixed by the entire surface of the same valve; but this character falls to the ground, from the fact that the same species sometimes assumes both modes of attachment,[9] and some were probably entirely free; nor do the internal dispositions of the muscular impressions warrant us to suppose that the animal was different in either case. Professor M'Coy proposes two other genera, *Pseudo-crania* and *Spondylobus*. The first is established on two Silurian species, the *C. antiquissima*, Eichw., sp., and *P. divaricata*, M'Coy, both are stated to have been unattached, but, as above observed, some well-known Cretaceous *Cranias* presented the same characters; the muscular scars in Professor M'Coy's species are very similar to those of *Crania*, the chief dissimilarities pointed out would appear to consist in the margin of the shell being smooth, or wanting the produced granulations, and in the vascular impressions; but these characters vary likewise to a great extent in different species of *Crania*. The Professor's

[1] *Crania oder*, &c., Berlin Gesellsch. Schrift, Brand ii, p. 66, 1781.

[2] Testacea utriusque Siciliæ, vol. ii, p. xxv, fig. 24.

[3] Zoologia Danica, 1777, tab. v, fig. 1—7.

[4] Cuvier; Tableau Elémentaire du Règne Animal, p. 435, 1798—"*Les orbicules* (*Orbicula*) . . . . . On ne connait de ce genre qu'une seule espèce (*Patella anomala*)—Müller." Refer likewise to Cuvier's celebrated "Mémoir sur l'Animal de la Lingule," 'Mém. du Mus.,' vol. i, 1802, in which he again states that *P. anomala* is the type of his genus *Orbicula*.—Lamarck's views were exactly the same as those of Cuvier, as may be seen by referring to the 'Système des Anim. sans Vert.,' p. 140, 1801.—Bruguière does not appear to have been the first proposer of the genus *Crania*, as stated by Dr. J. E. Gray, in the 'An. of Phil.' for 1825.

[5] The species described by myself under the name of *Orbicula*, in Part I, p. 7, and III, p. 9 and 10, do not belong to the genus *Crania*, but to *Discina* of Lamarck.

[6] A Monograph of English Permian Fossils, p. 84, 1849.

[7] British Pal. Foss. in the Camb. Mus., pp. 187 and 255, 1852.

[8] The first-mentioned species by Retzius is the *C. Brattenburgensis* = *nummulus* of Lamarck.

[9] See Part II, p. 11.

genus *Spondylobus*[1] seems to me very doubtful, and although far removed by the author from *Crania*, and placed among the *Lingulidæ*, would appear to be more nearly related to Retzius's genus.

Professor M'Coy states that in *Spondylobus* the larger valve is "slightly longer, from the apex being perfectly marginal and slightly produced, channelled by a narrow groove below, the anterior end of which is flanked by two very *prominent, thick, conical shelly bosses, representing hinge teeth.*" In *Crania Hagenovii* (De Kon.) there are two similar bosses,[2] which did not perform the office of hinge teeth, but were probably points of attachment for one of the sliding muscles.

Numerous and varied forms of *Crania* have been described and illustrated by several authors, and in particular by Hœninghaus[3] and Goldfuss,[4] who published beautiful monographs of the species of the genus known to them.

Geol. range.—*Crania* is one of the oldest types of animal life, it first appeared in the lower Silurian period, and has lived throughout all subsequent periods up to the present time.

Examples: C. Brattenburgensis, Stoboeus, sp.; *Ignabergensis,*[5] Retzius; *abnormis,* Def.; *costata,* Sow.; *antiqua,* Def.; *spinulosa,* Nils.; *antiquior,* Jelley; *Moorei,* Dav.; *Parisiensis,* Def.; *tuberculata,* Nils.; *ringens,* Hœnig.; *rostrata, gracilis, armata, intermedia, bipartita,* of Munster; *obsoleta,* Goldfuss; *Cénomaniensis,* D'Orb.; *anomala,* Müller; *Hagenovii,* De Kon., &c.

Family—DISCINIDÆ.

Animal attached by the means of a muscular peduncle, passing through the ventral or lower valve, a slit in the hinder portion, or a circular foramen excavated in the substance of the same valve. Arms fleshy; valves unarticulated.

In this family we have two or three *genera,* viz., *Discina, Trematis,* and *Siphonotreta.* The genus or sub-genus *Trematis,* as well as the sections *Orbiculoidea* and *Acrotreta,* will require further investigation before being definitely admitted.

[1] The species named as types, are *C. Sedgwickii,* Lewis, and *craniolaris,* M'Coy.

[2] My attention was called to this point by my friend Mr. Woodward.

[3] Beiträge zur Monog. der-Gattung Crania, 1828.

[4] Petrefacta Musei Universalis, 1840.

[5] This species was named after *Ignaberg,* a small village in Scania; Stoboeus, Retzius, and others have spelt it *Egnab,* an error I likewise committed in Part II, p. 11.

Genus—Discina, *Lamarck*, 1819.

Type—D. lamellosa, *Brod.*, sp. Int., Pl. IX, figs. 248—252.

Orbicula, of *Owen, Sow.*, &c., but not Orbicula, *Cuvier* or *Lamarck*.
Discina, *Lamarck, Gray, King, M'Coy, Philippi*, &c.

Shell circular, transversely or longitudinally oval; upper or *dorsal* valve[1] conical, patelliform, with the apex inclining towards the posterior margin; lower or *ventral* valve opercular, flat, or partly convex, and perforated by a narrow oval longitudinal slit, reaching to near the posterior margin and placed in the middle of an oval depressed disk. Valves unarticulated, being kept in place by four thick adductor muscles, passing rather obliquely from one to the other; surface smooth, ornamented by numerous striæ radiating from the apex to the margin, or by concentric lines of growth, produced in the shape of foliaceous expansions; shell structure horny, and perforated by minute tubuli. In the interior of the perforated valve the muscular disk is more or less prominent, and from the anterior extremity of the fissure a short longitudinal process arises. Four pairs of muscular impressions are visible on the disk; the posterior, submarginal pair, are probably those of the sliding muscle; the central four are the adductor scars, of which two lie on either side of the foramen, while the anterior pair are situated more towards the centre of the shell; the fourth pair lie external to these. In the upper valve, the posterior adductor scars are placed nearly horizontally, at a short distance from the margin, and are much smaller than the anterior pair, which lie obliquely near the centre of the valve; there are no projecting processes in the interior of this valve.

[1] In the letter addressed by Professor Owen to Professor M. Edwards, and published in the 'Ann. des Sc. Nat.,' vol. iii, 3d ser., p. 319, 1845; the learned Hunterian professor alludes to the valves of *Terebratula* and *Discina* (*orbicula* of Owen), as follows:—

"Pour en revenir aux *Térébratules*, j'ajouterai encore quelques mots relatifs à la manière dont j'envisage les rapports de position des parties molles et de la coquille. Dans le *Terebratula flavescens*, le pharynx est entouré d'un collier nerveux simple, et les principaux nerfs naissent de petits renflements situés aux angles du côté de ce collier qui avoisine la base transversale des bras frangés. Or, si le tube alimentaire était redressé par le tiraillement de la bouche et du pharynx en avant, cette base transversale des bras, et les points d'origine des nerfs analogues qui naissent ordinairement des ganglions sous-œsophagiens chez les Mollusques, plus élevés en organisation, seraient situés du côté de la grande valve perforée. Je considère par conséquent cette valve comme étant la *valve inferieure* ou *ventrale*, et la position du cœur vient à l'appui de cette opinion, puisque ce viscère se trouve plus près de la petite valve ou valve dorsale que ne l'est l'intestine. Jadis, j'ai décrit l'intestin comme se terminant du côté droit de la masse viscérale chez les Térébratules aussi bien que chez les Orbicules (*Discina*). Je persiste encore dans cette manière de voir; mais, dans l'Orbicule (*Discina*), la valve dorsale et imperforée est la plus grande et la plus convexe."

Fig. 47. Fig. 48. Fig. 49.

Discina lamellosa, Brod., Peru, Rev. W. Hennah.[1]

Fig. 47. *Animal, as seen on the removal of the lower valve, and part of the ventral mantle-lobe; the extremities of the labial arms are displaced forwards, in order to show their spiral terminations;* p, *is the expanded surface of the plug or pedicle; the mouth is concealed by the overhanging fringe.*

Fig. 48. *Dorsal mantle-lobe with its fringe of setæ.*

Fig. 49. *Ventral mantle-lobe* (*the setæ not represented*); f, *foramen, through which the fibres of the plug issue;* a, a, *anterior adductor muscles;* a′, a′, *posterior adductor muscles;* c, c, *protractor muscles;* c,′ c,′ *cardinal muscle;* r, r, *sliding muscle, or anterior visceral muscle of* Owen.

The *animal* of *Discina* is extremely delicate and transparent, allowing its internal organisation to be seen through the mantle. The mantle lobes do not adhere to the interior of the shell, which is smooth and polished; they are bordered with a dense fringe of long horny *setæ*, which are stiff and extremely brittle, resembling the bristles of certain Annelides (e. g., *Aphrodite*).[2] The relation of the animal to the perforate and imperforate valves is the same as in *Terebratula*, but as in *Crania*, the only process which can possibly have given any support to the oral arms at their origin, is developed from the centre of the *ventral* valve. The spiral extremities of the arms are directed towards the lower valve, and not dorsally, as in *Crania*. Professor Owen has shown in his anatomy of *Discina* (*Orbicula* 'Trans. Zool. Soc.,' 1833), that the valves must have been opened by a pair of oblique, or *sliding* muscles (*protractors*, *c*, *c*, fig. 48, 49); besides these there is a slender muscle (attached at the points *c′*, *c′*), similar to the cardinal muscle of

[1] From drawings made by Mr. Woodward: we are indebted to Dr. Gray, for permission to examine the specimens of *Discina*, preserved in spirits, in the British Museum.

[2] Professor Owen remarks, in p. 278, of his 'Lectures on the Comp. Anat. and Phil. of the Invertebrate Animals,' 1843: "That the margin is fringed with cilia, which are very long in Lingula and Orbicula (*Discina*). In the latter Brachiopod I found them beset with smaller cilia: these, with the brachial fringes and microscopic vibratile cilia, which, doubtless, beset the whole surface of the vascular mantle must be the chief agents in introducing the current of sea water within the cavity of the mantle for nutrition and excretion." It is, however, probable, that neither the brachial *cirri* or pallial *setae* are themselves vibratile organs. In certain species of *Terebratula* and *Spirifera*, the *cirri* had inflexible *calcareous supports*. (See Pt. III, Pl. II, fig. 18, and Pl. IV, fig. 2.)

Crania. The second pair of sliding muscles, by which the dorsal valve is restored to its place, is described as being attached at the points marked *r*, *r*. I failed in attempting to determine these, and also in ascertaining the points of attachment of the muscles of the peduncle.

Obs. Several authors, among whom we may mention Dr. Gray,[1] Professors King[2] and M'Coy,[3] have satisfactorily shown that the term *Orbicula*, having been applied by Cuvier, in 1798,[4] and subsequently likewise by Lamarck,[5] to *Patella anomala* of Muller, it ought not to be retained for the shells under description, as the species described by the Danish naturalist belongs to the genus *Crania*.[6]

For many years I felt unwilling to discard the term *Orbicula*[7] on account of its currency, occasioned by Professor Owen's description of the animal of *Discina* (*O.*) *lamellosa*;[8] but as the term *Orbicula* in the Cuvierian and Lamarckian sense is merely a synonym of *Crania*, we are obliged to adopt the genus *Discina*,[9] proposed and described by Lamarck, in 1819, and typified by *D. ostreoides*, a shell no doubt identical with *O. lamellosa* of Brodrip, but which never lived on the recent maritime shores of Great

[1] Annals of Philosophy, new series, vol. x, 1825; and An. and Mag. of Nat. Hist., vol. ii, 2d series, p. 439.

[2] A Monograph of Permian Fossils, p. 84, 1849.

[3] British Pal. Fossils in the Camb. Mus., 1852.

[4] Tableau Elémentaire du Règne Animal. "*On ne connait de ce genre qu'une seule espèce découverte par Müller en Danemarck, et rangée jusqu'ici parmi les Patelles; Patella anomala.*" In 1802, the same author states that Lamarck had adopted his views.

[5] Annales du Muséum, vol. x, 1807. In that mémoir, Lamarck places *Crania* in the family of *Oysters; Orbicula, Terebratula,* and *Lingula,* in the Brachiopoda. In 1801, the same author describes the genus *Orbicula*, founded on *O. Norvegica* = *Patella anomala* of Müller, and in 1819, distinctly states that it was *not* attached by a pedicle, but by the *substance* of the lower valve.

[6] The Baron de Ryckholt figures in his ('Melanges Paléontologiques,' pl. iv, fig. 3) specimens of *Crania obsoleta*, under the appellation of *Orbiculoidea Cimacensis*, said to be from the Devonian of Chimay and Ferque, in which the shell is bordered by a fringe, which he terms "*impressions ciliaires,*" and regards these as the remains of the horny *setæ* which surround the margin of the mantle of the recent animal, and which are also developed to a less extent in *Rhynchonella*. Not having seen the original specimens, I cannot offer an opinion, as to whether these beautiful examples really exhibit the fossilised border of the mantle, or only the fringed margin of the shell itself.

[7] In Parts I and III, I made use of the term *Orbicula* in the general sense, but not in that of Cuvier and Lamarck; the term *Discina*, will have to be there introduced, and *Orbicula* erased. Professor E. Forbes informs me, that "it would certainly be more convenient, under all circumstances, to prevent confusion, to use *Discina* instead of *Orbicula*, and to suppress altogether the latter name."

[8] Trans. of the Zool. Soc., vol. i, 2d part, 1833 (printed in 1835); and in the Annales des Sciences Nat., 1845.

[9] "*Discina; coquille inéquivalve, ovale-arrondie un peu déprimée; a valves de grandeur égale, ayant chacune un disque orbiculaire central très-distincte. Disque de la valve supérieure non percé, ayant au milieu une protubérance en mamelon; celui de l'autre valve très-blanc, divisé par une fente transversale.*" Lamarck, 'Hist. Nat. des Animaux sans Vertebrès,' vol. vi, p. 236, 1819.

Britain,[1] as supposed by that author. The only point on which great doubt may remain is the propriety of admitting the term *Orbiculoidea*,[2] proposed by M. d'Orbigny for a vast number of fossil species, considered by the generality of authors to be true *Discinæ*, but which the author of the 'Paléont. Française' states to have been provided with a regular pedicle, as in *Terebratula;* I am, however, convinced that many of the species thus denominated were attached, as in the typical *Discinæ*, and have had a portion of their pedicle fibres extending over the external disk; therefore, while introducing the term *Orbiculoidea* as a sub-section, I do so with the greatest reserve and doubt, as no internal characters have as yet been brought to bear on the subject.

Geol. range.—It is highly probable that the genus *Discina* was represented during the whole series of Geological periods up to the present day; but according to M. d'Orbigny the Palæozoic and Secondary species are generically distinct, and *Discina* first appeared at the Tertiary epoch, becoming more abundant in the present seas.

Examples: *D. lamellosa*, Brod.; *lævis*, Sow., sp.; *nitida*, Phil.; *Townshendi*, Forbes, sp.; *Cumingii*, Brod.; *strigata*, Brod., sp.; *striata*, Sow., sp.; ? *Morrisia*, Dav., sp.

? *Section* A.—Orbiculoidea, *D'Orb.*, 1847.[3]

Type—O. elliptica, *Kutorga*, sp. Int., Pl. IX, fig. 253—255.

Orbicula, of the generality of Authors.
Orbiculoidea, *D'Orbigny, De Ryckholt.*
Schizotreta, *Kutorga.*

Shell, sub-orbicular patelliform, longitudinally or transversely oval. Upper valve conical with the vertex close to, or removed from the posterior margin; *lower* valve conical or concave, no pedicle disk; ? a narrow oval or circular aperture, more or less confined in its shape, is situated in a furrow or depression.

Obs.—M. d'Orbigny characterises his section as follows:—"*Coquille de contèxture cornée non perforée, dont la valve inférieure concave est pourvue d'une ouverture laterale au crochet pour le passage d'un pedicule simple;*"[4] and supposes that these shells were

[1] In the Linn. Trans., vol. xiii, 1822. Sowerby falls into the same mistake made by Cuvier and Lamarck; since he considers the *Patella anomala* to be generically distinct from *Crania*. His observations relative to Lamarck's genus *Discina* seem essentially erroneous, as it is *quite impossible* the French author could have traced his characteristic of *Discina* from a specimen of *O. Norvegica*, which is a *Crania*, and therefore could not have presented the fissure and disk alluded to by the celebrated author above noticed.

[2] Cons. Zool. et Geol. sur les Brachiopodes, 1847.

[3] Considérations Zool. et Geol. sur les Brachiopodes; Comptes rendus de l'Académie des Sciences, August, 1847.

[4] Cours Elémentaire de Pal. et Geol. Stratigraphiques, vol. ii, p. 90, 1852. The author states to be acquainted with 27 fossil species.

fixed to submarine bottoms by a pedicle, which afforded greater freedom of motion to the animal than that of *Discina*. About the same period, Professor S. Kutorga likewise separated the above-mentioned shell from the Lamarckian genus, by the name of *Schizotreta*,[1] bringing forward similar reasons to those urged by the author of the 'Palæontologie Française;' but it is still very doubtful, if the section ought to be admitted.

Geol. range.—According to M. d'Orbigny, *Orbiculoidea* first appeared in the Silurian epoch, more numerous during the Carboniferous period, and disappeared in the Neocomian age.

Examples: O. elliptica, Kütorga, &c.

Section B. Trematis, *Sharpe*, 1847.

Type—T. terminalis, *Emmons*, sp. Int., Pl. IX, figs. 256—260.

Orbicula, of the generality of Authors.
Trematis, *Sharpe* (June, 1847).
Orbicella, *D'Orbigny* (August, 1847).

Animal unknown; *shell* somewhat depressed, sub-orbicular or transversely oval; both valves slightly and unequally convex, giving a lenticular form to the shell; umbo of the upper or imperforated valve submarginal, slightly projecting. Lower or ventral valve with a sub-central umbo, behind which a narrow, oblong, oval slit reaches to near the posterior margin, and afforded passage to the pedicle fibres of attachment. Internal dispositions unknown, a wide cardinal margin is visible in the imperforated valve.

Obs. Mr. Sharpe proposed to separate from *Discina* certain shells which in their general external appearance bore much resemblance to that genus, but appeared to differ by others, which he thus defined:[2] "*The valves are united by a hinge*, of which the details cannot be seen in the specimens; *but it is probably formed* of two diverging lamellar processes in the dorsal valve, for where the shell of that valve has been worn away we can trace three calcareous plates diverging from the *hinge* of the dorsal valve, as in the Leptænoid species of *Orthis*, and in many of the Spirifers. Wherever these plates are found in the Brachiopoda, the outer pair appear to be continuations of the teeth or lamellar processes of the hinge; so that the presence of such plates is sufficient to *show* that the valves played upon a hinge. The third or mesial plate separates the two great adductor muscles." The above statements require, however, further examination before being admitted, nor have I been able to obtain examples adding much light to the subject; but I am far from being convinced that *Trematis* was provided with an articulated hinge resembling that of *Terebratula;* on the contrary, I am inclined to believe the valves were un-

[1] Ueber dei Siphonotretaeæ aus den Verhandlungen der Kaiserlichen Min. Ges. für das Jahr 1847.

[2] Quart. Journal of the Geol. Soc., No. 13, vol. iv, p. 66.

articulated, and kept together by special muscles, as in *Discina*. Mr. Sharpe further observes, that "the shell consists of layers of two distinct structures; the outer layer is *punctated; the punctations* are so large as to be clearly visible to the naked eye, and are arranged quincuncially with great regularity. The inner layers of the shell are not punctated, and have a fibrous and slightly striated appearance and pearly lustre; these *impunctate* layers are thickest towards the middle of the shell, and do not quite reach the margin. It thus appears that the genus *Trematis* differs from *Orbicula* (*Discina*) in the punctated structure of the shell, and in having the valves united by a hinge, while it is distinguished from *Terebratula* and other hinged forms of Brachiopoda, by the ligament passing through the ventral valve." Having submitted a specimen of *Trematis terminalis* to Dr. Carpenter's microscopic examination, that gentleman informs me "*that it does not depart in any essential particular from the type of Discinidæ, the punctated surface being (as in Porambonites), a mere superficial conformation; and Mr. Sharpe's internal unpunctated layer being a succession of laminæ, just as in Discina, and that every thing now tallies satisfactorily in regard to the conformity between the general characters of the shell and its intimate structure.*"

In August 1847, M. d'Orbigny proposed for the same shells, the name *Orbicella*,[1] which must be considered as a synonym, Mr. Sharpe's paper having been published a month before that of the French author! M. d'Orbigny does not allude to a hinge or diverging plates, he mentions that the *structure of the shell* (which he erroneously states to be punctated), and *the convexity of the perforated valve* are the principal distinctions he had observed, the animal being fixed to submarine bottoms by a pedicle similar to that of *Terebratulæ*.[2] From all the above, it seems questionable whether the shells here described deserve to be erected into a distinct *genus*. They probably constitute simply a section of *Discina;* but as nothing is known of the internal impressions and characters, I shall for the present admit it with reserve and doubt.

Geol. range.—This section seems to have originated in the Silurian period, above which no examples have as yet been discovered.

Examples: T. terminalis, Emmons, sp.; ? *cancellata*, G. Sow.; ? *punctata*, Sow., sp.

Genus—SIPHONOTRETRA, *De Verneuil*, 1845.

Type—S. UNGUICULATA, *Eichw.*, sp. Int., Pl. IX, figs. 261—268.

CRANIA (UNGUICULATA), *Eichwald.*
TEREBRATULA (part), *Eichw.*
SIPHONOTRETRA, of all modern Authors.

[1] Considérations Zoologiques et Géologiques sur les Brachiopodes; Comptes rendus des Sciences de l'Académie des Sciences; Paris, 5 Août, 1847.

[2] In the An. and Mag. of Nat. Hist., vol. iv, 2d ser., p. 316, 1849. Mr. Morris seems to doubt that *Trematis* was the same as *Orbicella*, D'Orb.; a reference to the types mentioned by both authors will convince any one of the correctness of my statement.

Animal unknown. *Shell* oblong oval, inequivalve; valves unarticulated; *larger* or *ventral valve* most convex, with a straight, thick, perforated, conical beak, more or less removed from the hinge line; foramen circular or elongated, opening on the back of the beak, and communicating with the interior of the shell by a cylindrical tube or siphon, destined to afford passage to the muscle of attachment; no area nor deltidium; each valve has a wide, crescent-shaped cardinal edge, covered by numerous horizontal lines of growth. *Smaller valve* slightly convex and depressed, the hinge-line forming an arch which merges imperceptibly into the lateral margins. Structure calcareo-corneous, with a distinctly punctured structure arranged in tubular layers; surface smooth, but presenting numerous lines of growth, and scattered or closely packed, slender, hollow spines, dilated at their base, and somewhat quincuncially arranged; no calcified supports for the arms. Muscular impressions unknown.

Obs. One of the species composing this remarkable genus was noticed in 1829,[1] but it was only in 1845,[2] that M. de Verneuil established the genus *Siphonotreta*, which has been recognised and adopted by all subsequent naturalists, on account of the clearly defined characters which separate it both from *Crania* and *Terebratula*, where it had been located, as well as from all the other genera.

Subsequent and most valuable information was thrown on the subject by the memoir of Dr. Kutorga,[3] in which beautiful illustrations and structural details had been delineated with the greatest care. Mr. Morris, who first determined its occurrence in England, (from a specimen in the cabinet of John Gray, Esq., of Dudley,) has likewise added some details.[4] M. de Verneuil pointed out that *Siphonotreta* should be placed near *Lingula* and *Discina*, but it is distinguished from the first by the pedicle not passing between the beaks, and from the second by the form of the perforated valve. I differ, however, from my learned friend in his belief that the perforated beak of *Siphonotreta* corresponds to the imperforate one of *Terebratula*. Mr. Morris considers the genus allied to *Crania;* and Professor King places it in his family *Craniadæ*. Professor Forbes includes *Orbicula* and *Crania* in the same family. My views coincide with those of M. de Verneuil, and I prefer placing it with *Discinidæ*, because the shell differs materially from *Crania* by its remarkable siphon or pedicle opening, no such aperture being visible in any species of the last named genus, while it would be nearly related to *Discina* and *Orbiculoidea* by being fixed by a pedicle issuing from an aperture. Its spines cannot be made use of as a generic character of much value, the same being common to other genera. Mr. Morris states that the spines are moniliform in the English species, a character not yet found in the Russian types.

[1] Professor Eichwald; Zoologia Specialis (*C. unguiculata*).

[2] Russia and Ural Mountains, vol. ii, 1845.

[3] Uber die *Siphonotretaeae*, by Dr. S. Kutorga, Verhandlungen der Kaiserlichen Mineralogischen Gesellschaft für das Jahr 1847.

[4] Annals and Mag. of Nat. Hist., vol. iv, 2d ser., 1849.

Geol. range.—The genus has not hitherto been discovered above the Silurian deposits.

Examples: S. unguiculata, Eichw., sp.; *verrucosa,* Vern.; *fornicata,* Kut.; *comoides,* Kut.; *Anglica,* Morris; *micula,* M'Coy.

Section A. *Sub-Genus*—?Acrotreta, *Kutorga,* 1848.[1]

Type—A. subconica, *Kut.* Int., Pl. IX, figs. 271—275.

Animal unknown; *shell* triangular, larger valve conical; false area flat, and bent back at right angles to the margin of the valve, longitudinally grooved along the centre, and perforated at its extremity by a small circular aperture, the lines of growth encircle the shell and pass uninterruptedly over the false area; the smaller valve is almost flat and operculiform, smooth, and marked by concentric lines of growth. Valves unarticulated?

Obs. Never having been able to procure the inspection of any examples of the species composing this genus, I can offer no decided opinion on the subject. Professor Kutorga places this section in his family *Siphonotretaeae*; Mr. Morris, on the contrary, seems disposed to consider *Acrotreta* identical with *Cyrtia,*[2] in which opinion I cannot coincide, if the figures drawn by the distinguished Russian Palæontologist be correct, and of which I feel little doubt. The shape of the false area, the hollow groove, and the perforation of the summit of the truncated beak, are characters not observable in any species of *Cyrtia.*[3]

Geol. range.—Not hitherto observed above the lower Silurian beds of Russia.

Examples: *A. subconica, disparirugata,* and *recurva,* Kut.

Family—LINGULIDÆ.

Animal fixed by a muscular peduncle passing out between the beaks of the valves; arms fleshy, unsupported by calcified processes. Shell unarticulated and sub-equivalve; texture horny.

Obs. The family is composed of two genera, *Lingula* and *Obolus.*

[1] Uber die *Siphonotretaeae* aus den Verhandlungen der Kaiserlichen Mineralogischen Gesellschaft für Jahr 1847, tab. vii, figs. 7—9.

[2] Ann. and Mag. of Nat. Hist., vol. iv, No. 23, p. 315, 1849.

[3] Having communicated on the subject with my friend Dr. Volborth, of St. Petersburgh, that gentleman states—"Sur aucun de mes exemplaires d'*Acrotreta* je n'ai pu constater de charnière ni d'apophyses dentaire; mais le nombre des echantillons est si petit que je n'oserai émettre une opinion positive à se sujet; cependant la physionomie générale de cette espèce la rapproche tellement des *Siphonotretaeae* que je leur assignerai des valves libres tant que je n'aurai les charnières et les dents devant moi."

Genus—LINGULA, *Bruguière*, 1789.

Type—L. ANATINA, *Lamarck*. Int., Pl. IX, figs. 276—279.

PATELLA, *Gmel.* (part).
PINNA (part), *Chemnitz*.
MYTILUS, *Dillwyn*.
LINGULA, of all modern Authors.

Shell thin, sub-equivalve, equilateral, more or less elongated, oval or sub-pentagonal, tapering at the beaks, widened at the pallial region; valves unarticulated, held together by the adductor muscles; both slightly convex, but depressed, beak of the valve more pointed and rather exceeding the other in length; surface smooth or concentrically striated, and covered by an epidermis. *Animal* attached to submarine bottoms by the means of a long peduncle passing out between the beaks of the two valves; no calcified supports; on each side of the mouth is situated an elongated subspiral arm, fringed exteriorly with numerous cirri. In the interior, several muscular impressions are visible; close to the beak are the conjoined depressions left by the pedicle muscle (A), under these, and laterally near the margin of the shell exist two large impressions due to the decussating muscle which produces the sliding action of the valves on each other (B), and towards the centre are situated two small oblique oval scars, caused by the posterior pair of adductor muscles (C), which in the larger valve are divided by a blunt rounded projection, and in the smaller by an elongated mesial elevated crest; under the last described impressions another triangular depression was occupied by the combined extremities of the anterior pair (D): shell almost entirely composed of laminæ of horny matter, perforated by minute tubuli.

Fig. 50.

Lingula anatina.

Obs. Professor Owen having described the anatomical characters of the animal, I shall only notice that Cuvier was the first author who pointed out the internal dispositions of this remarkable genus,[1] and which prompted him to create a special class, to which he applied the term *Brachiopoda*.

Geol. range.—This genus is among the most ancient forms of animal life; it first appeared in the lowest Silurian epoch, and has continued uninterruptedly to the present period, where it is still represented by several forms living on the shores of tropical regions, and varying so little in external aspect through its long continued existence as to render specific distinctions often difficult to appreciate.

Examples: L. anatina, Lam.; *hians*, Swains; *Audebardi*, Brod.; *semen*, Brod., *albida*, Hinds; *Dumortieri*,[2] Nyst; *ovalis*, Sow. (non Reeves); *Lewisii*, Sow.; *Beanii*,

[1] Mémoir sur l'Animal de la Lingule (*L. anatina*, Lam.), Mém. du Muséum, vol. i, p. 69, pl. vi, 1802.

[2] In Part I, this species is every where erroneously spelt *Dumontieri*.

Sow.; *truncata*, Sow.; *quadrata*, Eichw.; *squamiformis*, Phil.; *spatulata*, Hall; *Credneri*, Geinitz; *tenuigranulata*, M'Coy; *Davisii*,[1] M'Coy, &c.

Genus—Obolus, *Eichwald*, 1829.[2]

Type—O. Apollinis, *Eichwald*. Int., Pl. IX, figs. 280—285.

Obolus, *Eichwald, De Verneuil, D'Orbigny*, and the generality of Authors.
Ungula, *Pander*.[3]
Orthis, *V. Buch* (part).
Aulonotreta, *Kutorga*.[4]

Animal unknown. *Shell* sub-equivalve, orbicular, equilateral, slightly transverse or elongated, depressed; valves unarticulated, being held together by muscular action. The *larger valve* (ventral of Owen) is most convex, with a short obtuse or pointed beak, and wide flattened cardinal edge or false area, over which the semicircular concentric lines of growth of the surface pass uninterruptedly; the flattened cardinal edge is longitudinally grooved by a semicylindrical furrow, destined to afford room for the passage of the muscular fibres of attachment; *smaller valve* rather shorter than the other, slightly convex or almost flat, without any prominent beak or vertex, the hinge line forming a regular arch, and passing imperceptibly into the lateral margins; the cardinal edge is likewise flattened and horizontally striated, but not interrupted by a mesial furrow; external surface smooth or irregularly sculptured by minute undulating wrinkles. Structure calcareo-corneous. In the interior of the larger valve, a narrow slightly elevated longitudinal ridge extends to about half the length of the valve, and four small oval muscular impressions are situated one on each side near the cardinal angles, and the other two towards the centre of the valve, a little beyond the base of the mesial ridge.

Obs. The genus *Obolus* was created by Professor Eichwald for the reception of two Russian shells, which could not be properly admitted into any of the sections hitherto established. MM. de Verneuil, Pander, D'Orbigny, Morris, &c., have most properly considered *Obolus* a member of the family *Lingulidæ:* the manner in which the pedicle passes between the beaks being essentially similar to that of *Lingula*, the structure is rather more solid than that of the last named genus, and from Dr. Carpenter's microscopic examination would appear to be impunctuate; the muscular impressions though different in their details bear also some analogy to those of *Lingula*. Professor Kutorga has ably described and illustrated this genus, in his paper on the *Siphonotretacæ*, wherein

[1] This is the most ancient species at present known, see Professor M'Coy's paper, in the 'Ann. and Mag. of Nat. Hist.,' vol. viii, p. 405; and to Mr. Salter's very interesting observations on the *Lowest Fossiliferous beds of North Wales*, in the 'Reports of the Brit. Ass.,' for 1852.

[2] Zoologia Specialis, vol. i, p. 274.

[3] Beiträge zur Geognosie der Russischen Reich, 1830.

[4] Uber die *Siphonotretaeae*, Verhandlungen der Kaiserlichen Min. Gesellschaft für das Jahr 1847.

he changes the name to *Aulonotreta*, and objects to Professor Eichwald's denomination because the shell under consideration does not resemble the old Greek coin *Obolus*, and does not think far-fetched names befitting; but were we to reform all the absurd denominations existing in science, no material good would be procured, and immense confusion, on the other hand, would ensue. If, therefore, a name is not essentially objectionable, it should not be changed, and we will therefore retain the old name *Obolus*, which has become current in science.[1] I have already stated the reasons for not admitting the genus under consideration into the same family with *Siphonotretaeae*, and for placing it, on the contrary, close to *Lingula*.[2]

Geol. range.—*Obolus* is one of the most ancient forms, abounding in the lower Silurian beds of Russia, and in the Wenlock Shales of England, above which no authenticated example has been as yet observed.[3]

Examples: *O. Apollinis*, Sch. (=*A. polita*, Kut.); *sculpta*, Kut., sp.; *Davidsoni* and *transversa*, Salter, sp.

[1] See also Mr. Morris's observations, in the An. and Mag. of Nat. Hist., vol. iv, 2d ser., 1849.

[2] I take this occasion to express my sincere thanks to Dr. Volborth and Professor Kutorga for having enabled me to examine, and kindly presented me with an extensive series of examples of this and other Russian forms.

[3] Having recently been requested by Mr. Salter to examine some curious impressions and internal casts derived from the Wenlock shales of Walsall, Parker's Hall, Dudley, and Woolhope, with a view of ascertaining the genus to which they belonged, I was not a little interested to find, after a minute comparison with an extensive series of *Obolus Apollinis* and *sculpta*, that our English Upper Silurian Fossil really belonged to the Russian genus, which had not hitherto been noticed above the Lower Silurian Rocks of Russia. Our British specimens appear to belong to two distinct species, and attained considerable dimensions, one of them is of a transversely oval shape, and appears to have been a thin shell, while the other is more circular, and appears from the depth of the muscular and other impressions to have been a very thick shell. Mr. Salter will shortly describe the two forms under the names of *O. Davidsoni* and *O. transversa*, and in order to facilitate the comparison of the different muscular impressions, I have accompanied these few observations by woodcuts illustrating both the Russian and British species.

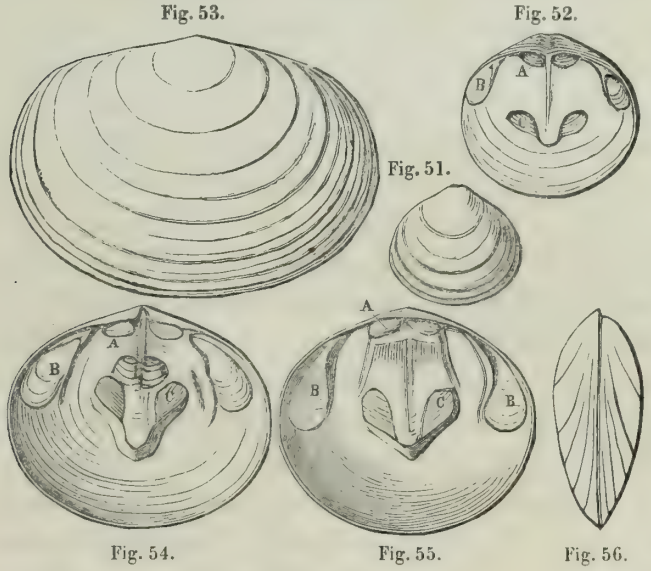


Fig. 51. Obolus Apollinis, *from Ruma.*
„ 52. *Interior of the ventral valve.*
„ 53. O. transversa (*Salter*).
„ 54. O. Davidsoni (*Salter*), *Dudley, interior of ventral valve.*
„ 55. *Interior of dorsal valve.*
„ 56. *Side view of both valves.*

PLATE I.

Fig.

1. The anatomy of *Terebratula flavescens*, exposed by the removal of the right moieties of the valves, pallial lobes, and bent portions of the fringed arms. Magnified 4 diameters.

2. A dissection of the *Terebratula flavescens*, showing the muscular system, peduncle, and calcareous loop. The valves have been divaricated at the hinge. Magnified 6 diameters.

3. The visceral mass and cavity exposed in the cardinal part of the perforated valve of the *Terebratula flavescens*. Magnified 6 diameters.

4. The alimentary canal laid open, and part of the liver of the *Terebratula flavescens*. Magnified 20 diameters.

5. The anatomy of *Lingula anatina*, exposed by the removal of the valve and pallial lobe answering to the ventral ones in *Terebratula*, and principally to show the auricles, 1, 1, and the intestinal sinus, 8. Magnified 3 diameters.

6. The alimentary canal, liver, and intestinal venous sinus of *Lingula anatina*. Magnified 12 diameters.

7. Five embryos, removed from the ovarian cavity in the pallial sinus of *Lingula anatina*. Magnified 120 diameters.

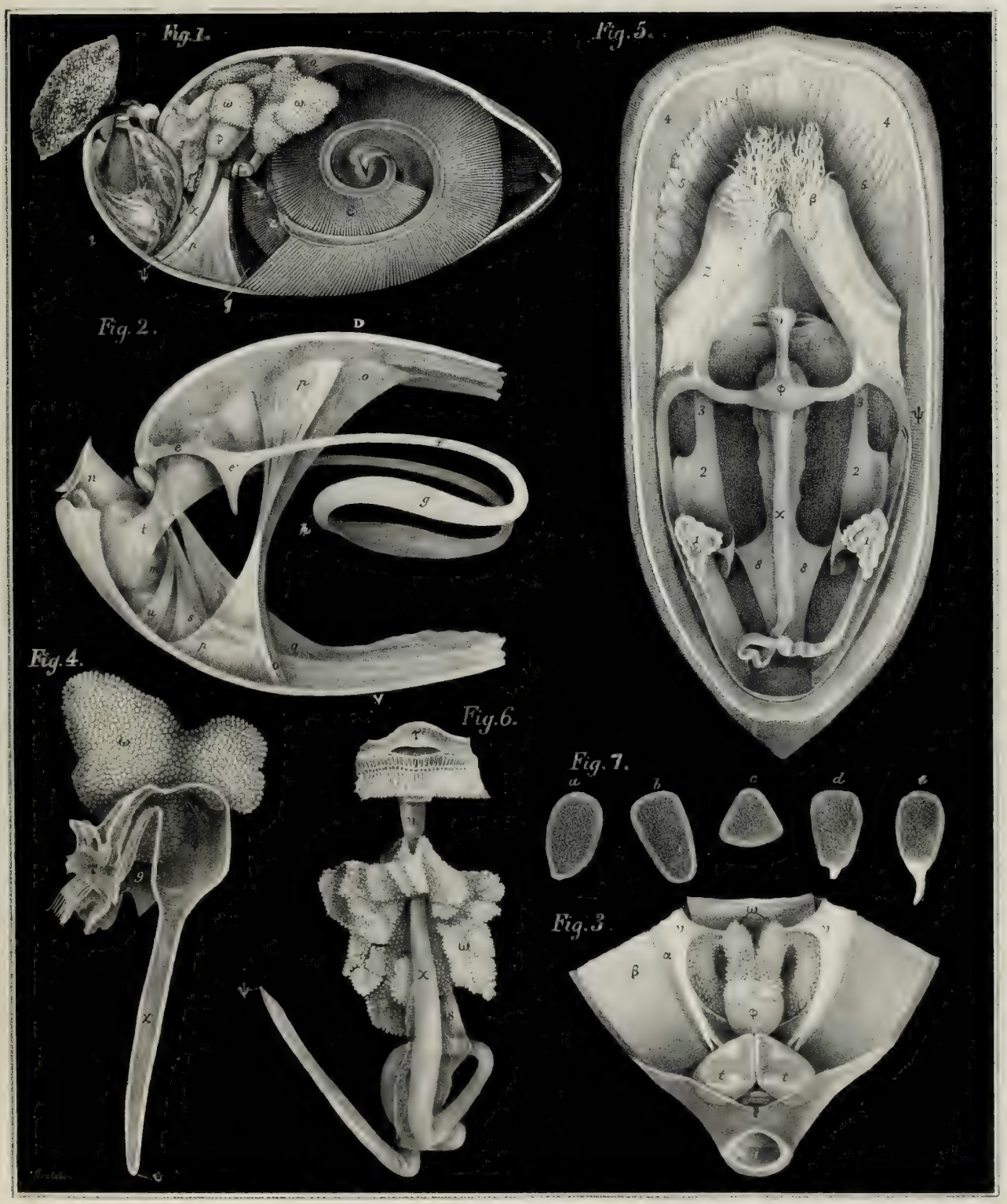


Fig. 1.
Fig. 2.
Fig. 3.
Fig. 4.
Fig. 5.
Fig. 6.
Fig. 7.

PLATE II.

Fig.

1. The brachial aponeurosis and spiral arms of *Terebratula flavescens*, showing the central part of the nervous system, with the brachial and beginning of the pallial nerves. Magnified 6 diameters.

2. The peduncle and a large proportion of the soft parts of *Terebratula flavescens*. showing the principal ramifications of the pallial nerves or the dorso-pallial fold of the mantle. Magnified 12 diameters.

3. Some of the soft parts of *Lingula anatina*, exposed by the removal of the valve and pallial lobe, answering to the ventral ones in *Terebratula*, and of the digestive organs, chiefly to show the trunks of the visceral and muscular nerves. Magnified 4 diameters.

Fig. III.

Fig. 1.

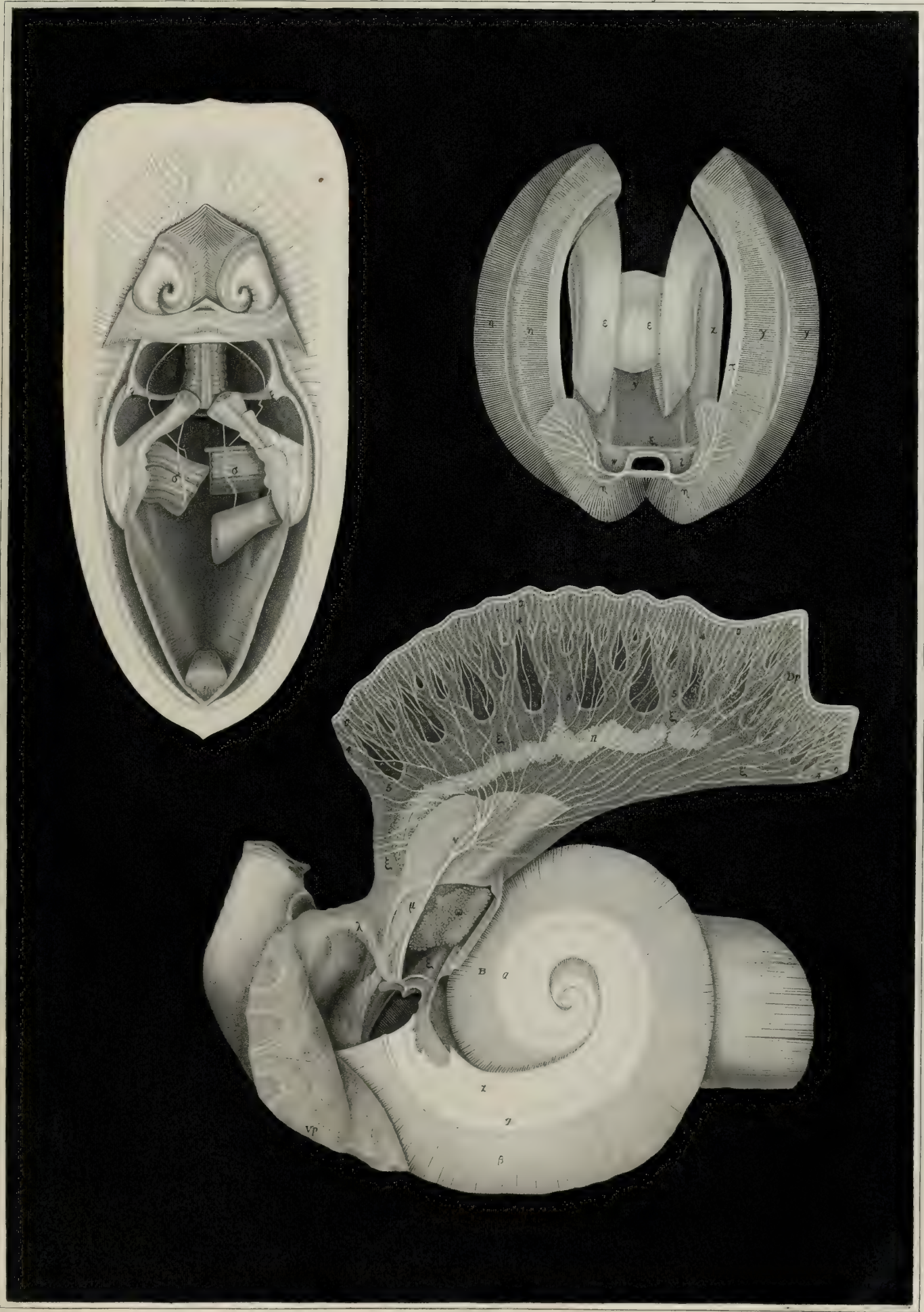


Fig. II

PLATE III.

Terebratula flavescens.

Fig.

1. The visceral mass and portions of the mantle-lobes, dissected to show the hearts and principal venous sinuses. Magnified 8 diameters.

2. The soft parts, as seen from the dorsal aspect, and exposed by the removal of the dorso-pallial fold and spiral extremity of the arms. Magnified 6 diameters.

3. A similar view of the soft parts, with a minor degree of dissection.

The following are the letters or marks of reference used for the same parts in each of the figures.

D Dorsal, or imperforate valve.

a Cardinal process.

b Dental sockets.

c Cardinal plate.

d Median crest.

e Crus, or basal process, of loop.

e' Descending process of loop.

f Produced plate of loop.

g Reflected plate of loop.

h Transverse, or confluent plate, of loop.

IMPRESSIONS OF

o' Adductor longus anticus.

p' „ „ posticus.

q' Adductor brevis.

V Ventral, or perforate valve.

i Foramen.

k Deltidium.

l Cardinal teeth.

Fig. I

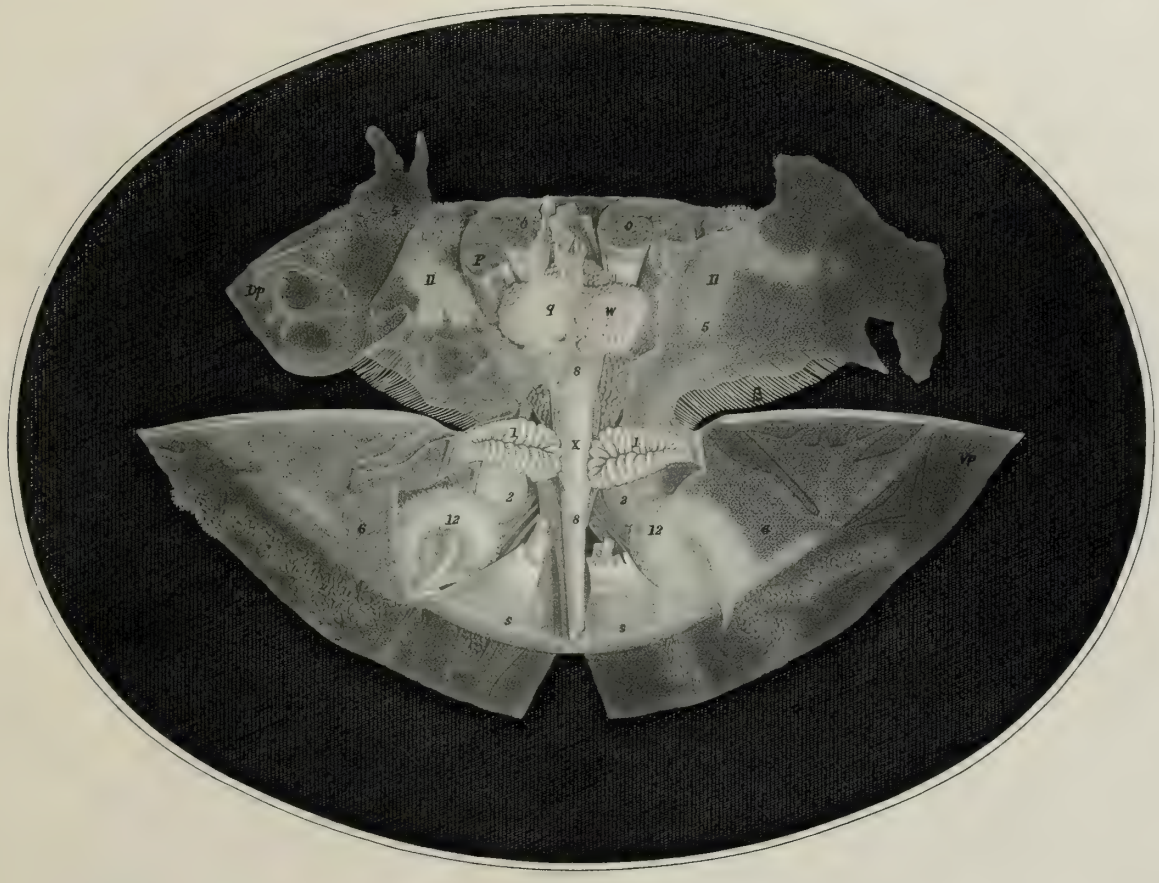


Fig. II

Fig. III

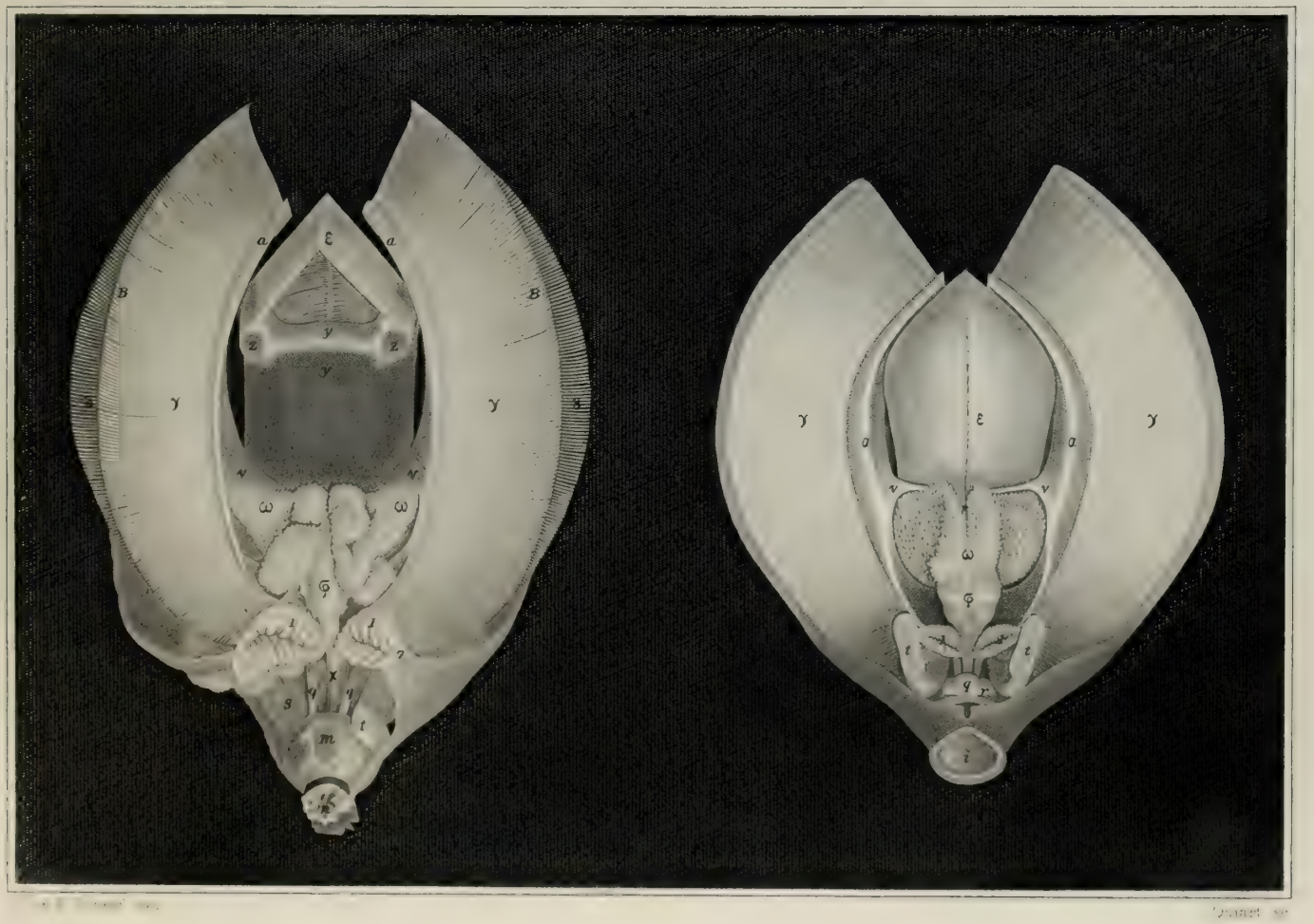


PLATE IV.

Fig.

1. Vertical section of the perforated valve of *Waldheimia* (*Terebratula*) *australis*, through the median plane, from the beak at A to the margin at B; showing that it mostly consists of but one layer, everywhere traversed by vertical passages. At *a a*, *b b*, and *c c*, are indications of the successive marginal additions which the shell has received. The layer, separated by the line *d d*, has the appearance of being a production subsequent to the general enlargement of the shell, apparently for the purpose of strengthening its older and thinner portion.—Magnified 6 diameters.

2. Portion of vertical section of the loop-bearing valve of *Terebratella rubicunda*, taken in the transverse direction through the origin of the calcareous appendages, *a a*. The higher magnifying power enables the vertical passages to be more distinctly seen; and it is shown that the calcareous appendages are not traversed by them.—Magnified 18 diameters.

3. Portion of fig. 1, near the extremity A, considerably enlarged, so as to show the ordinary trumpet-like form of the vertical passages, and the remarkable contraction which they exhibit in the inner and (probably) later-formed layer. The line *d d*, corresponds with the same line in fig. 1.—Magnified 100 diameters.

4. Another portion of fig. 1, at the part C, considerably enlarged, showing the occasional bifurcation of the vertical passages. Magnified 100 diameters.

5. Fragments of the shell of *Kraussia rubra*, separated by spontaneous disintegration.—Magnified 100 diameters.

6. Thin lamella of shell of *Waldheimia* (*Ter.*) *australis*, showing the parallel disposition of the flattened prisms, and the regular arrangement of the passages which intervene between them; and at *a* the outcrop of these prisms on the internal surface of the shell.—Magnified 100 diameters.

Fig.

7. Internal surface of shell of *Waldheimia* (*Ter.*) *australis*, showing the imbricated arrangement of the extremities of the prisms, which are seen longitudinally at *a*.—Magnified 100 dimeaters.

8. External surface of shell of *Waldheimia* (*Ter.*) *australis*, showing the large trumpet-shaped ends of the vertical passages, covered-in by the opercular disks, which have radiating lines proceeding from them. Magnified 100 diameters.

9. Calcified membrane of the shell of *Waldheimia* (*Ter.*) *australis*, having attached to it some of the cæcal tubuli, crowded with cells. Magnified 150 diameters.

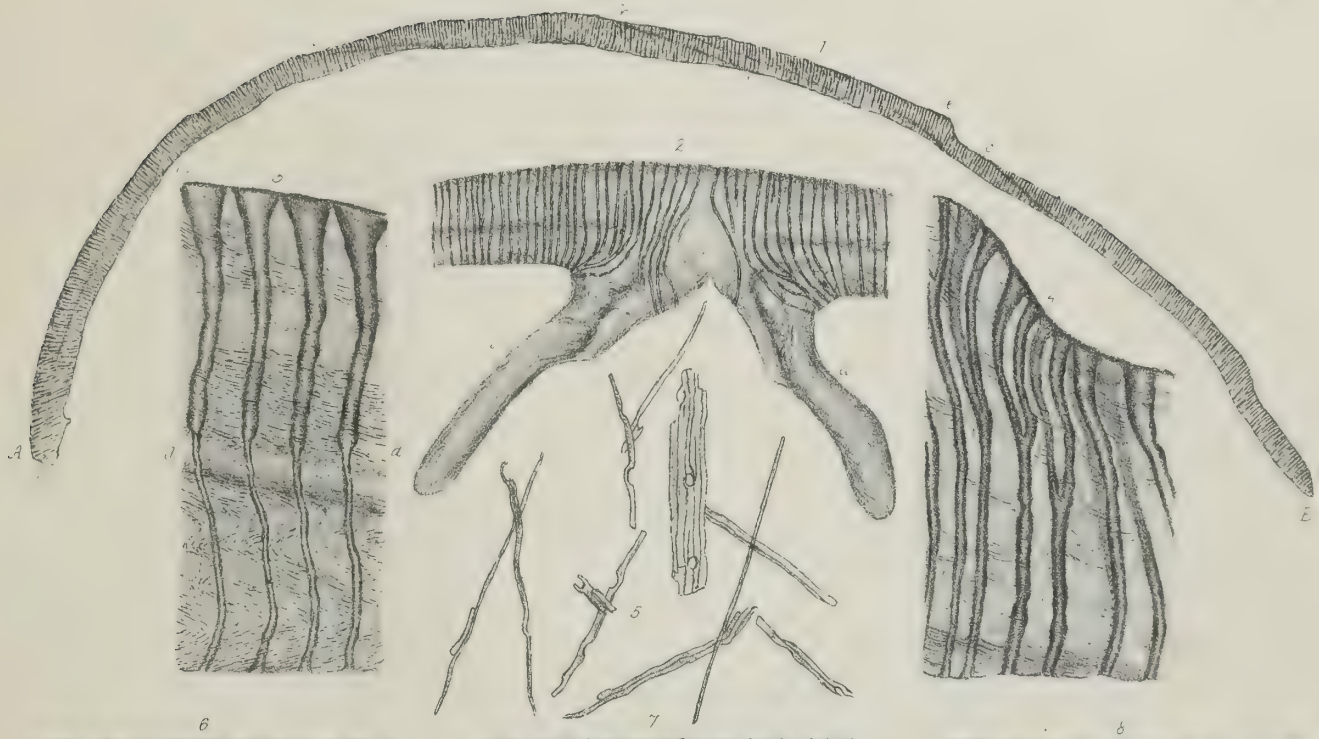
10. Portion of the surface of the calcareous loop of *Waldheimia* (*Ter.*) *australis*, showing the imbricated arrangement of the extremities of the flattened prisms, and the absence of perforations.—Magnified 100 diameters.

11. Portion of the internal surface of the shell of *Terebratulina caput-serpentis*, showing the imbricated arrangement, and the internal orifices of the vertical perforations, arranged in rows.—Magnified 100 diameters.

12. Portion of the external surface of the shell of *Terebratulina caput-serpentis*, showing the external orifices of the perforations, opening somewhat obliquely upon the ridges of the plications.—Magnified 100 diameters.

13. Portion of the shell of *Terebratulina caput-serpentis*, partially decalcified by maceration in acid, showing the cæcal tubuli, *in situ*.—Magnified 100 diameters.

14. Portion of the internal surface of the shell of *Megerlia truncata*, showing the usual imbricated arrangement and the internal orifices of the vertical perforations, with two of the peculiar elevations or 'bosses,' on which no passages open.—Magnified 100 diameters. [N.B. By an oversight on the part of the artist, the surface of these bosses is not represented as partaking of the general imbricated character of that of the rest of the shell, which is really the case.]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A
B
2
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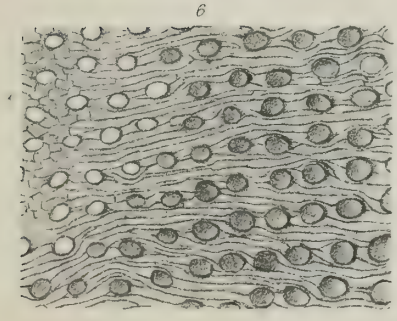
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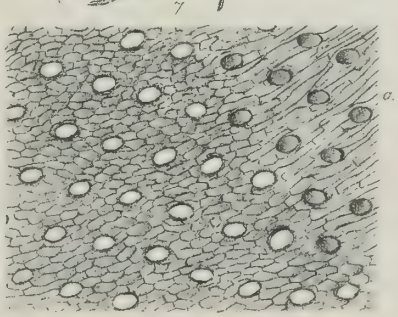
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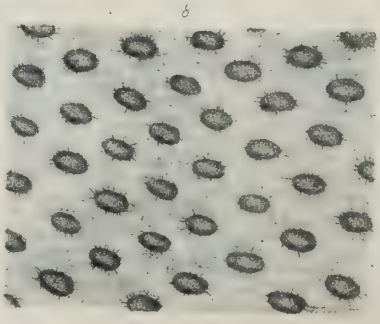
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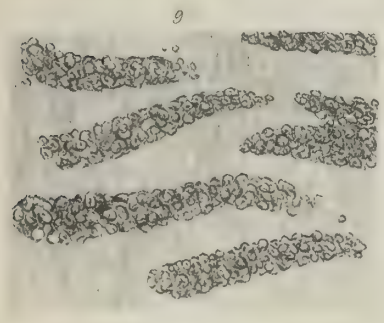
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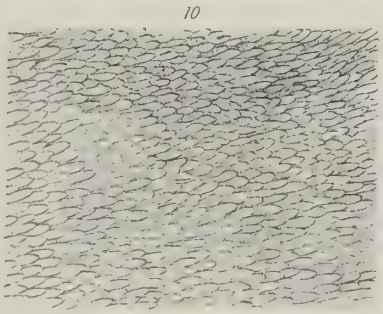
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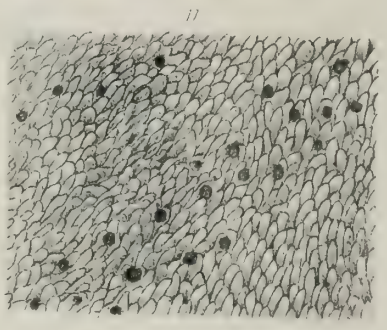
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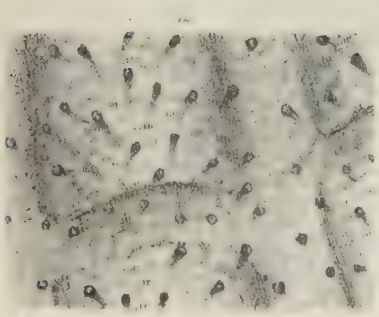

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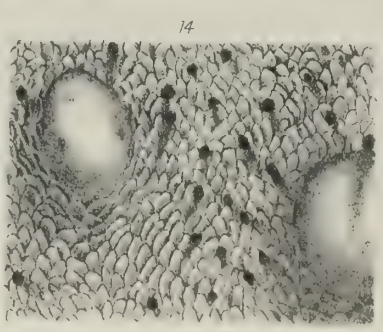
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PLATE V.

Fig.

1. Section of the shell of *Terebratula bullata* (Oolitic), near the external surface, and parallel to it, showing the remarkably large size and close proximity of the perforations.—Magnified 100 diameters.

2. Section of the shell of *Megerlia lima* (Cretaceous), taken in the like direction, showing the very small size and wide separation of the perforations.—Magnified 100 diameters.

3. Section of the shell of *Spiriferina rostrata* (Triassic), taken in the like direction, showing the extremely large size and close proximity of the perforations, and the appearance presented by the oblique division of the flattened prisms of which the shell is composed.—Magnified 100 diameters.

4. Portion of the shell of *Rhynconella psittacea* (Recent), showing at *a a* the internal surface, with the imbricated arrangement of the extremities of its component prisms, and at *b b* the aspect of the prismatic substance as displayed by a fracture nearly in the direction of the length of the prisms, showing also the entire absence of the least trace of perforations.—Magnified 40 diameters.

5. Portion of the internal surface of the shell of *Rhynconella psittacea*, more highly magnified, showing the imbricated arrangement, and the entire absence of perforations.—Magnified 100 diameters.

6. Portion of shell of *Rhynconella octoplicata* (Cretaceous), showing the peculiar oblique striation of its component prisms, as displayed by a fracture the plane of which passes in the direction of their length.—Magnified 100 diameters.

7. Internal surface of the marginal portion of the shell of *Crania antiqua* (Cretaceous), as seen under a low power, showing the large orifices of the perforations.—Magnified 17 diameters.

8. Vertical section of the unattached valve of *Crania Norvegica* (recent), showing its successive layers, traversed by vertical channels, which present an arborescent division near the external surface, and a marked contraction near the interior;

Fig.

at *a* is seen a partial layer of prismatic substance arranged vertically, which was probably the seat of the muscular attachment in the young shell; at *b* a similar layer, in the situation of the muscular attachment in the adult shell.—Magnified 40 diameters.

9. Portion of the internal surface of the shell of *Crania Norvegica*, which affords the muscular attachment, highly magnified, showing the extremities of the component prisms, and the large orifices *a a* of the perforations.—Magnified 150 diameters.

10. External surface of the shell of *Thecidium pumila* (Recent), showing large orifices of perforations arranged in rows.—Magnified 100 diameters.

11. Portion of decalcified membrane of *Crania Norvegica*, with its attached cæca, these sometimes bifurcated.—Magnified 100 diameters.

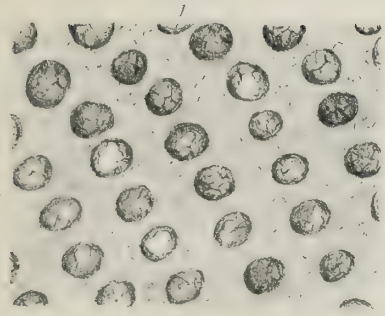
12. External surface of the shell of *Crania Norvegica*, showing the radiating arrangement of the subdivisions of its canals.—Magnified 100 diameters.

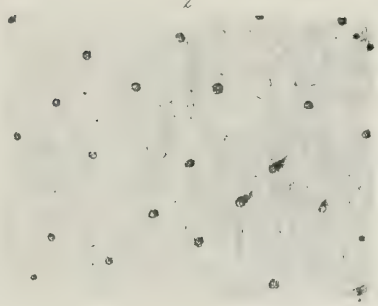
13. Decalcified membrane of the prismatic portion of the shell of *Crania Norvegica*, showing at *a a* the cells in their longitudinal aspect, and at *b b* their truncated extremities.—Magnified 150 diameters.

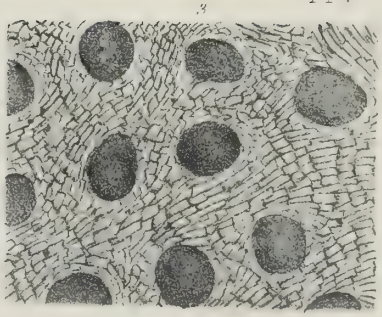
14. Vertical section of shell of *Strophomena aculeata*, showing the shell *a a* to be traversed by perforations *b b*, round which the shell-structure is arranged in a funnel-like manner; *c c*, the matrix, the substance of which has penetrated the canals.—Magnified 34 diameters.

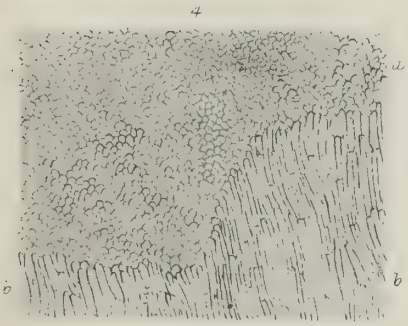
15. Section of shell of *Strophomena aculeata*, nearly parallel to the surface, showing the perforations divided transversely at *a a*, and obliquely at *b b*.—Magnified 34 diameters.

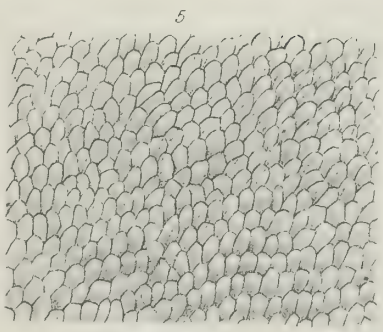
16. Section of shell of *Discina lamellosa*, showing its minutely tubular structure obliquely divided at *a a*, and transversely divided at *b b*, where the tubuli seem to lie in clusters, presenting an appearance of cellular arrangement; at *c* a more distinct indication of cellular structure presents itself.—Magnified 150 diameters.

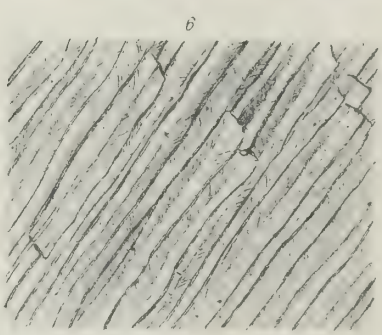


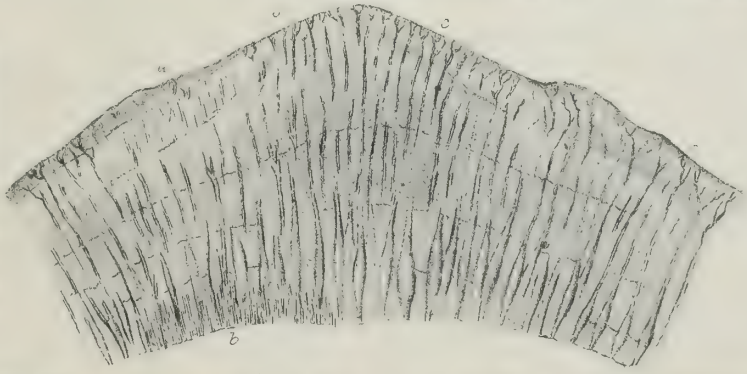


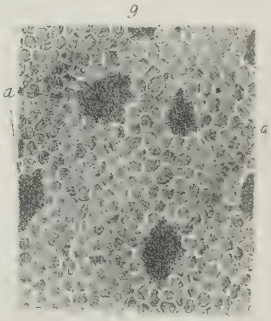


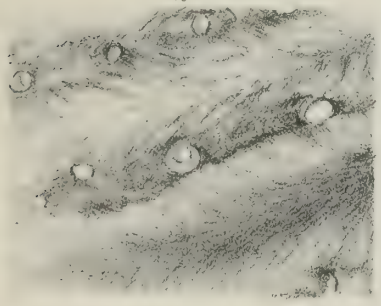


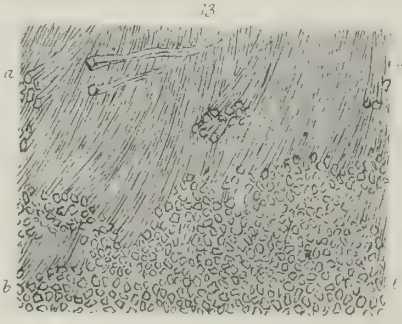


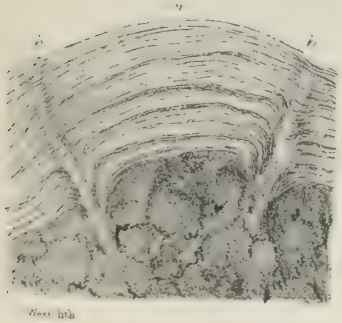


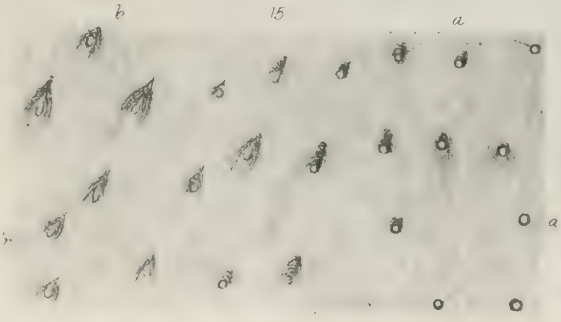


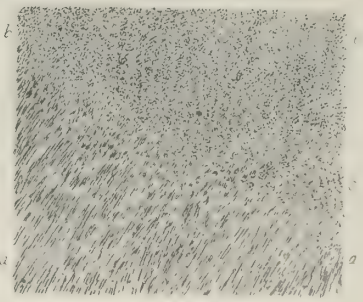












Ford & West, Imp 54, Hatton Garden.

PLATE VI.

The following Letters refer to the same parts and impressions in every figure.

A, *adductor muscle* (*add. longus*, Owen); R, *cardinal muscles* (*add. brevis* and *cardinalis*, Owen); P, *pedicle muscles* (*retractor sup.* and *inf.*, Owen); J, *cardinal process*; L, *loop*; T, *teeth*; B, *sockets*; D, *deltidium*; V, *vascular impressions*; O, *ovarian spaces*; S, *septum*, &c.

Fig.

1. TEREBRATULA VITREA. *Loop only once attached, and short.*
2. „ „ Interior of dorsal or socket valve.
3. „ *diphya*. Type of the genus *Pygope* of Link, *antinomia* of Catullo.
4, 5, 6. „ *elongata* (5 loop), 6 is a portion of internal cast, shewing the place of the dental plate, X.
7. *Terebratulina caput serpentis*.
8. „ „ Interior of dorsal valve.
9. *Waldheimia flavescens*, Lam. (*australis*, Quoy), type of Professor King's section.
10. „ „ Interior of dorsal valve.
11. TEREBRATELLA CHILENSIS. Type of M. d'Obigny's section.
12. „ „ Interior of dorsal valve, shewing the *double attachment of the loop*.
13. „ „ Section to exhibit the septum, S.
14. „ *Evansii*. Section to shew the largely developed septum, S, in this species.
15, 16. *Trigonosemus elegans*, Koenig = *Fissurirostra*, D'Orbigny.
17, 18. *Terebrirostra lyra*.
19. MAGAS PUMILA.
20. „ „ Interior of dorsal valve.
21. „ „ Section of both valves, to shew the largely developed septum, S, &c.
22. BOUCHARDIA TULIPA, Blainv. = *rosea*, Mawe, &c.
23. „ „ Interior of ventral or dental valve.
24. „ „ Interior of dorsal or socket valve.
25. „ „ Section of both valves.
26. *Megerlia truncata*.
27. „ „ Interior of dorsal valve.
28. KRAUSSIA RUBRA, Pallas, sp.
29. „ „ Interior of dorsal valve.
30. MORRISIA ANOMIOIDES, Scacchi, sp. = *T. appressa*, Forbes. Exterior, O, ovarian impressions, V, labial appendages seen through the translucent shell.
31. „ „ Interior of *dorsal* or *socket* valve, shewing the large notch for the passage of the peduncle in this valve.
32. ARGIOPE DECOLLATA.
33. „ „ Interior of dorsal valve, shewing 5 ridges, Z, and the position of the loop.
34. „ *Neapolitana*. Interior of dorsal valve, as an example where the loop is only bilobed, one septum or ridge only existing.
35, 36. THECIDIUM RADIATUM, Def., type of the genus. This species was attached by a small portion only of the extremity of the beak.
37. „ „ Interior of dorsal valve, Z, dissepiments; L, apophysary ridge for the support of the arms and brachial membrane; W, bridge-shaped process.
38. „ „ Interior of ventral valve.
39. „ *hieroglyphicum*. Interior of dorsal valve.
40. „ *digitatum*. Ditto.
41. „ *hippocrepis*. Ditto.

Fig.

43 & 46. THECIDIUM *Deslongchampsii*. Interior of dorsal valve and profile, to shew the surface of attachment, *f*.

44. „ *sinuata*, E. Desl. Exterior, *f*, point of attachment.

45. „ „ Interior of dorsal valve.

47. „ *Moorei*. Profile to shew the extent of attachment in this species, *f*.

48. SPIRIFER STRIATUS, Martin, sp. Type of the genus. Interior of dorsal valve, shewing the internal spires, from a specimen in the Cambridge Museum.

49. „ „ Interior of *ventral* or *dental valve*, from a specimen in the British Museum.

50. „ *Lonsdalii*. Interior of *dorsal* or *socket valve*, from a specimen in the British Museum.

51. „ *speciosus*. Viewed from the beaks, to shew the double areas and pseudo-deltidium.

52. „ *Mosquensis*. Interior of *ventral* or *dental valve*, type of Fischer's genus *Choristites*.

53. „ *Cyrtæna*. Interior of *ventral valve*.

54. „ *Verneuilii*. = genus *Trigonotreta*, Kœnig.

55. „ *Paillettii*. To show the large development of the mesial fold in this species.

56. „ *cheiropteryx*.

57. „ *glaber*. Type of M'Coy's genus *Martinia*.

58. „ *reticulatus* = genus *Reticularia*, M'Coy.

59. „ *hemisphæricus* = genus *Brachythyris*, M'Coy.

60. *Spiriferina rostrata*. Interior of *ventral* or *dental valve*; type of D'Orbigny's genus *Spiriferina*.

61. *Cyrtia trapezoidalis*. Type of Dalman's genus *Cyrtia*; F, foramen.

62. „ „ A fragment of the area and deltidium, to shew that at a certain age the foramen is closed; in a species from Belgium and China (*C. Murchisoni*), the circular foramen exhibits a tubular expansion, as seen in some *Rhynchonellæ*, such as *R. octoplicata*, &c.

63. *Cyrtia? heteroclyta*. Exterior.

64. „ „ Interior of *ventral* or *dental valve*.

65. SPIRIGERA CONCENTRICA. Exterior.

66. „ „ Interior of *dorsal* valve, showing the largely developed hinge plates, and four pits for the insertion of the pedicle muscles; *n'* visceral? foramen, communicating with the tube.

67. „ „ Interior of ventral valve.

68. „ *pectinifera* = genus *Cleiothyris*, King (not Phillips).

69. „ *plano-sulcata* = genus *Actinoconchus*, M'Coy, exhibiting the largely developed marginal expansions.

70. „ *phalæna*, Phil., sp. = *Hispanica*, Vern.

71. ATHYRIS TUMIDA. Interior of ventral valve.

72. „ „ Fragment of the interior of dorsal valve, to show the mesial septum not occurring in *Spirigera*.

73. „ *Herculea*, Barrande, sp.

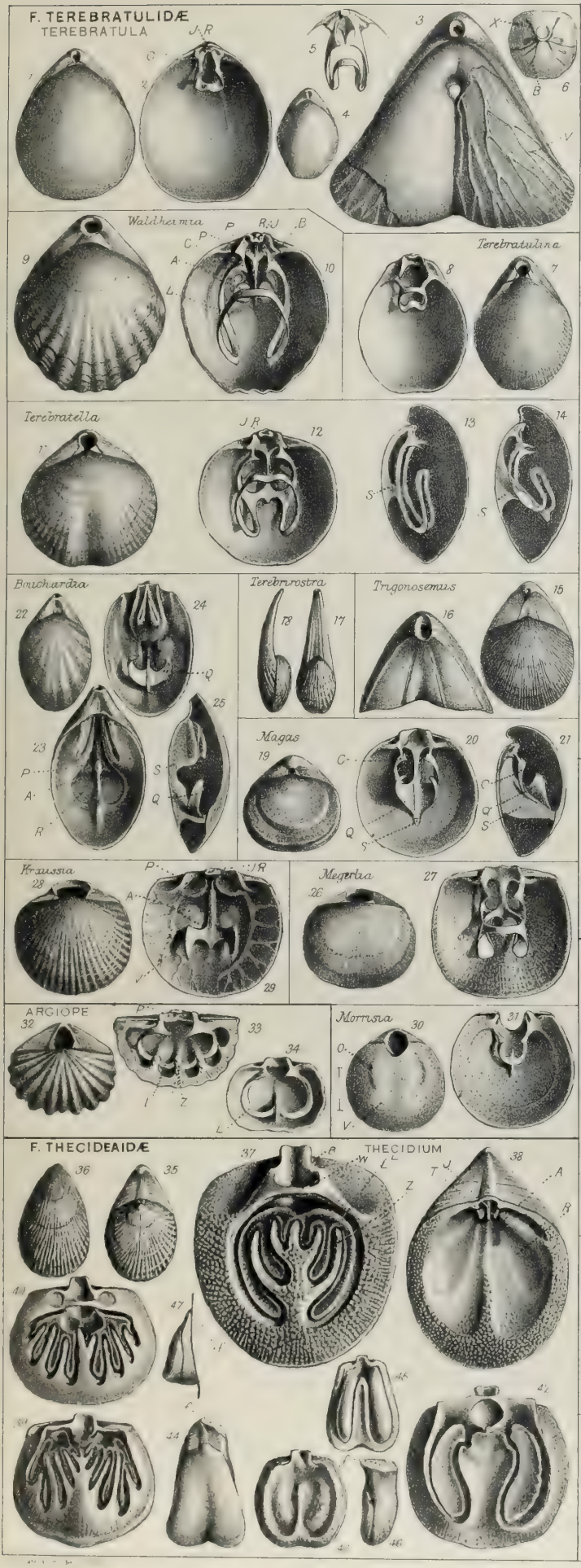
74. „ „ Specimen in which a small portion of the beak and umbo has been removed to exhibit the shoe-lifter shaped process, *e'*, on which repose the dental plates, X; S, septum in dorsal valve.

75. „ „ A specimen seen from the beaks, in which a portion of the shell has been removed, so as to exhibit the shoe-lifter process, *e'*, and dental plates, X.

76. „ „ Section of both valves to shew the largely developed dental plates in the ventral valve, and septum in the dorsal one. Fig. 74, 75, and 76, were kindly communicated to me by my friend Mr. Suess, of Vienna.

77. *Retzia Adrieni*, Vern., sp., type of Professor King's genus *Retzia*.

78. *Spirigera? mucronata*, Vern., sp. D, deltidium.


F. TEREBRATULIDÆ
TEREBRATULA
Waldheimia
Terebratulina
Terebratella
Bouchardia
Terebrirostra
Trigonosemus
Magas
Kraussia
Megerlia
ARGIOPE
Morrisia
F. THECIDEAIDÆ
THECIDIUM

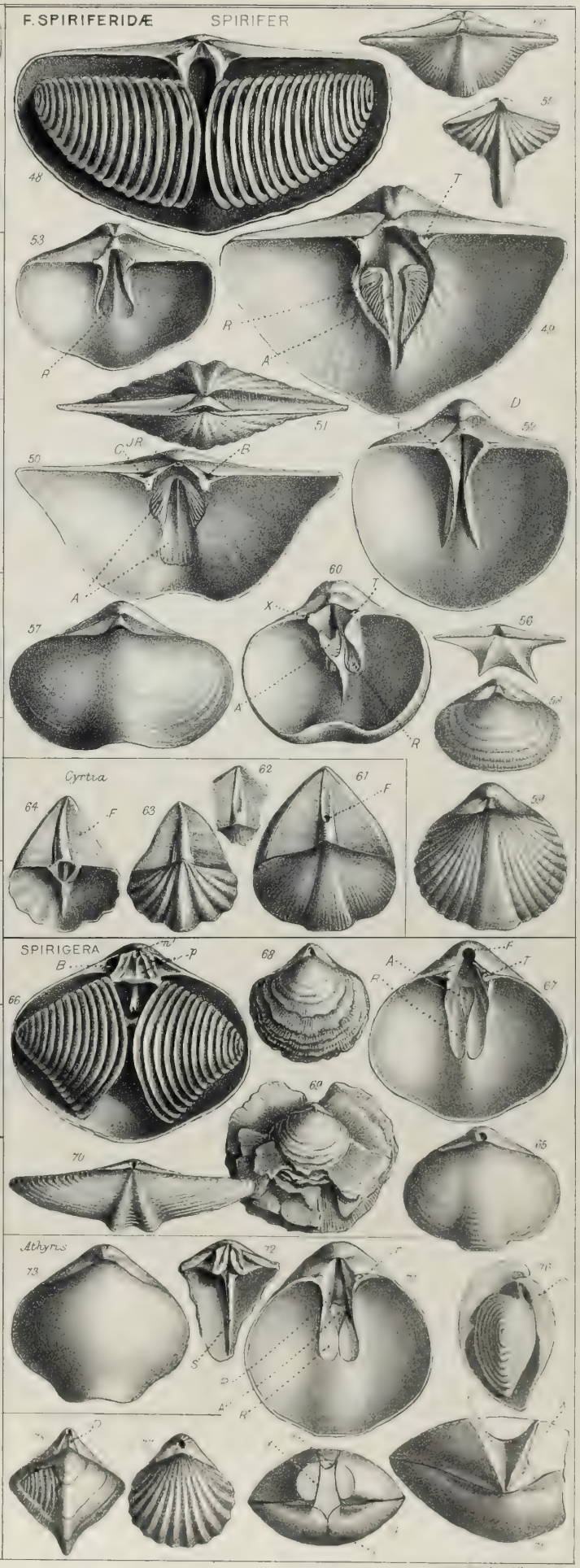

F. SPIRIFERIDÆ
SPIRIFER
Cyrtia
SPIRIGERA
Athyris

PLATE VII.

The following letters refer to the same parts and impressions in every figure.

A, *adductor muscle* (*add. longus*, Owen); R, *cardinal muscles* (*add. brevis* and *cardinalis*, Owen); P, *pedicle muscles* (*retractor sup.* and *inf.*, Owen); J, *cardinal process*; L, *loop*; T, *teeth*; B, *sockets*; D, *deltidium*; V, *vascular impressions*; O, *ovarian spaces*; S, *septum*, &c.

Fig.

79. UNCITES GRYPHUS. A Belgian specimen, shewing the depressions in the lateral portions of the beak, g''.

80. ,, ,, Profile of the same, a portion of the shell having been removed, so as to show that the pouch-shaped depressions do not communicate with the interior of the shell; g', portion belonging to the dorsal valve; g'', that of the ventral valve.

81. ,, ,, Profile of a specimen from Paffrath, in which the lateral depressions do not exist.

82. ,, ,, A young individual from Chimay, considerably enlarged, to show that in the young state the shell was fixed by means of a peduncle, issuing from a perforation in the beak of the ventral valve.

83. ,, ,, The extremity of the beak considerably enlarged, to shew the foramen and deltidium.

84. ,, ,, A horizontal section of the hollow beak.

85. ,, ,, Interior of a specimen from Paffrath, in the Collection of Professor Beyrich, of Berlin, exhibiting traces of the spiral lamellæ which supported the arms. This sketch was kindly communicated to me by M. Suess, of Vienna, with Professor Beyrich's permission.

86. ,, ,, A specimen from Chimay, showing the position of the pouch-shaped expansions (g'', those belonging to the ventral valve), and the attachment of the crural lamellæ forming the spires.

87. ATRYPA RETICULARIS, Linn., sp. The first-mentioned type of Dalman's genus *Atrypa*, and of his first division *striatæ*; in this Silurian example no trace of the foraminal aperture is visible.

88. ,, ,, from the Eifel, exhibiting in the most beautiful manner the foramen and deltidium.

89. ,, ,, Interior of dorsal valve, showing the natural position of the spiral cones.

90. ,, ,, Interior of *ventral valve*, from a specimen discovered by M. de Koninck (now in the British Mus.), and in which the vascular impressions are beautifully illustrated.

91. ,, ,, Interior of *dorsal valve*, from which the spires have been removed, in order to exhibit the portion of the quadruple impressions left by the adductor muscle.

92. ,, ,, Interior, from which the largest portion of the shell of the dorsal valve has been removed, to shew the position and shape of the spiral cones; from a beautiful example in the cabinet of Prof. Buckman.

93. ,, ,, A transverse section, to show the extent of space occupied by the spiral cones; M, ventral; N, dorsal valve.

93 *bis*. ,, *marginalis*, Dalman, sp.

94. ,, *prunum*. Type of Dalman's 2d section *læves*.

95. STRINGOCEPHALUS BURTINI. Exterior, showing foramen and deltidium.

96. ,, ,, A young example from Belgium, with large triangular aperture.

97. ,, ,, A fragment of the interior of both valves, from a specimen in the collection of M. de Koninck: J, cardinal forked process; *c*, portions of the stems or origin of the loop. (See pp. 74 and 75, *for figures of the loop*.)

98. ,, ,, Fragment of the *dorsal valve*, to illustrate the hinge plates, crura of the loop, cardinal process and quadruple impression of the adductor.

Fig.

99. RHYNCHONELLA LOXIA, Fischer, from Moscow, type of the genus *Rhynchonella* of Fischer.

100. ,, *psittacea*, genus *Hemithyris* of M. d'Orbigny; D, deltidium.

101. ,, ,, Interior of *dorsal valve*: *n'*, foramen for the passage of the intestine.

102. ,, ,, Interior of the *ventral valve*.

103. ,, *octoplicata*. A fragment of the interior, to show the position of the teeth, and dental plates, X.

104 & 107. ,, *scaldinensis*, D'Archiac, to show the tubular expansion of that portion of the deltidium which encircles the foramen.

105. ,, *rimosa*. To show that from the great incurvature of the beak, there exists no visible foramen in some species.

106. ,, *concinna*. Fragment of the beak, to show that the deltidium does not always surround the entire foramen, which is partly completed by the umbo of the dorsal valve.

108, 109. CAMAROPHORIA SCHLOTHERMI. Type of the genus.

110. ,, ,, A specimen with lamellose marginal expansions, from the collection of Professor King.

111. ,, *multiplicata*, King. Internal cast.

112. ,, ,, Interior of a portion of both valves. In the *dorsal valve* is seen the disposition of the *septum*, S; *spatula shaped process*, G; curved lamellæ to which the oral arms were attached, C; cardinal process, J. In the *ventral valve*, the septum, S, and conjoined dental plates, X.

113. ,, ,, Section of the same, to shew the projection of the different parts; both these last figures are drawn from specimens kindly lent me by Professor King.

114. PENTAMERUS GALEATUS, Dal. The letter S, indicates the position of the septa in the *dorsal* and *ventral valves*.

115. ,, ,, Longitudinal section of the same.

116. ,, *Knightii*. Type of the genus. Longitudinal section, shewing the position and shape of the largely developed septa and plates.

117. ,, *galeatus*. Transverse section, to shew the relative position of the parts visible in the longitudinal section, fig. 115.

118. ,, *liratus*. A fragment of the dorsal valve, from a specimen in the Mus. of Prac. Geol., shewing, besides the adductor impressions, the processes, C, to which the spiral arms were attached.

119. ,, *linguiferus*. Exterior.

120. PORAMBONITES ÆQUIROSTRIS, Schl., sp. Viewed from the beaks; the letters B and X indicate the place and position of the plates.

121. ,, ,, Profile of the same.

122. ,, ,, Fragment exhibiting external sculpture (not punctation).

123, 124. ,, *intercedens*, Pander.

125, 126. ,, *Ribeiro*, Sharpe. Internal cast, showing the position of the plates, and muscular and vascular system, from a specimen in the collection of Mr. Sharpe.

127. ORTHIS CALLIGRAMMA.

128, 129. ,, *striatula* or *sinuata*, showing the double area and fissures, = genus *Schizophoria*, King.

130. ,, ,, Interior *of ventral valve*, from Nehou.

131. ,, ,, Interior of *dorsal* or *socket valve*, from Nehou.

132. ,, ,, Fragment of the same valve, from a specimen from Chimay.

133. ,, ,, Internal cast of the *dorsal valve*, drawn from a beautiful specimen presented by M. de Koninck to the British Museum, shewing the quadruple impression of the adductor, ovarian spaces and vascular impressions.

134. ,, *elegantula*, Dal. Interior of dorsal valve.

135. ,, *resupinata*. Interior of dorsal valve, from a specimen in the British Museum.

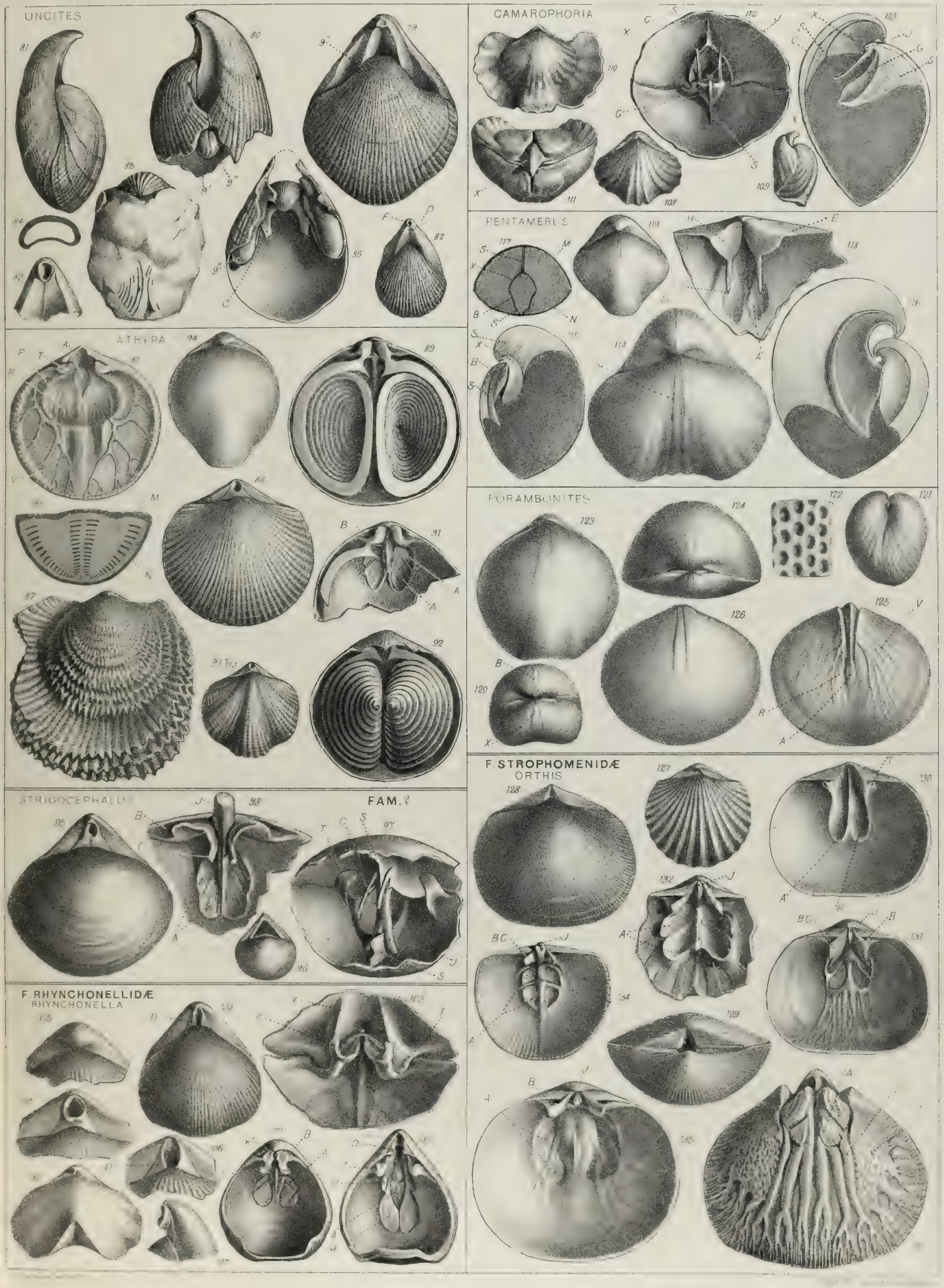

UNCITES
CAMAROPHORIA
PENTAMERUS
ATRYPA
PORAMBONITES
STRIGOCEPHALUS
FAM.?
F. STROPHOMENIDÆ
ORTHIS
F. RHYNCHONELLIDÆ
RHYNCHONELLA

PLATE VIII.

The following Letters refer to the same parts and impressions in every figure.

A, *adductor muscles* (*add. longus*, Owen); R, *cardinal muscles* (*add. brevis* and *cardinalis*, Owen); P, *pedicle muscles* (*retractor sup.* and *inf.*, Owen); J, *cardinal process*; L, *loop*; T, *teeth*; B, *sockets*; D, *deltidium*; V, *vascular impressions*; O, *ovarian spaces*; S, *septum*, &c.

Fig.

136. ORTHIS RUSTICA, Sow.
137. ,, ,, Interior of dorsal valve.
138. ,, ,, Interior of ventral valve.
139. ,, ,, The double area and fissures.
140. ,, *elegantula*.
141—144 ,, *biloba*, Linn., sp. = genus *Dicælosia*, King.
145. ,, ,, Interior of dorsal valve.
146. ,, *biforata*, Sch., sp. = genus *Platystrophia*, King.
147. ,, ,, Interior of *ventral* or *dental valve*.
148. ,, ,, Interior of *dorsal* or *socket valve*.
149. ORTHISINA ADSCENDENS, Pander, sp. = genus *Pronites* and *Hemipronites*, Pander.
150. ,, *anomala*, Schl., sp.
151. ,, ,, Interior of dorsal valve, from a specimen in the collection of M. de Verneuil.
152. ,, *hemipronites*. Viewed from the beaks, to illustrate the double area and closed fissures.
153. ,, *plana*. Interior of ventral valve, from a specimen in the collection of M. de Verneuil.
154. ,, ,, Interior of dorsal valve.
155. ,, ? *senilis*, viewed from the beaks.
156. ,, ? *pelargonatus* = genus *Streptorhynchus*, King.
157. STROPHOMENA PLANUMBONA, Hall. (*Dorsal valve convex.*)
158. ,, ,, Interior of ventral valve.
159. ,, ,, Interior of dorsal valve.
160. ,, *alternata* (Conrad). Interior of *dorsal valve*.
161. ,, ,, Fragment of the beak, to show the position of the foramen.
162. ,, *expansa*, Sow., sp. Drawn partly from the original specimen, figured by Sir R. Murchison, in the 'Silurian System,' pl. xx, fig. 14; and from another example in the Mus. of Prac. Geol.
163, 164. ,, *pecten*, Linn., sp.
165. ,, *narangoana*, Vern., sp. No fissure or deltidium interrupts the area.
166. ,, *latissima*, Bouchard. Ibid.
167, 168. ,, *depressa* or *rhomboidalis*. No foramen seen in this specimen.
169. ,, ,, Young example of the same, from Dudley, in which the perforation or temporary foramen is clearly seen.
170. ,, ,, Interior of dorsal valve.
171. ,, ,, Interior of ventral valve.
172. ,, ,, Section of the valves.
173. ,, ,, Interior of ventral valve, from a specimen from Gothland, in the collection of Professor King, showing curious sub-spiral labial impressions; a similar example has been figured by Professor Quenstedt. (Handbuch der Petref. tab. xxxix, fig. 20.)

Fig.

174. Strophomena *analoga*. Fragment of the interior of the ventral valve, to show the different muscular impressions and foramen.

175. „ „ Fragment of the beak, to show the aperture.

176, 177. Leptæna transversalis, Dal. 177 section.

178. „ „ Interior of ventral valve.

179. „ „ Interior of dorsal valve.

180. „ „ View of the double area.

181, 182. „ *transversa*, Pander = genus *Plectambonites*, Pander.

183. „ *Davidsonii*, Eng. Deslongchamps. *Lias*, France.

184. „ *oblonga*, Pander.

185. „ „ Interior of dorsal valve.

186. Davidsonia Verneuili, Bouchard.

187. „ „ Interior of ventral or dental valve, from the specimen figured by M. de Verneuil (Geol. of Russia, pl. xv, fig. 9).

188. „ „ Interior of ventral valve, showing the vascular impressions, &c.

189. „ „ Interior of dorsal valve (enlarged), from the specimen described by M. de Koninck, and now in the British Museum.

190, 191. „ „ A specimen in the collection of M. de Koninck.

192. „ *Bouchardiana*, de Kon. Exterior, natural size.

193. „ „ Interior of the dorsal valve, from the original specimen figured by M. de Koninck, and now in the British Museum.

194, 195. Koninckina Leonhardi, Wissman, sp.

196. „ „ Interior of dorsal valve, with a portion of the spiral lamella preserved.

197. „ „ Translucid specimen made thinner by acid, and seen from the exterior of the ventral valve.

198. „ „ Section of the valves. These last three enlarged illustrations were drawn and forwarded to me by Mr. Suess, of Vienna.

198 bis, 199. Chonetes lata, Sow., sp., from Ludlow.

200. „ n. sp. The interior of the dorsal valve, from the Devonian Limestone of Nehou, and showing besides the muscular scars, the reniform impressions, v, which prove that this section should be classed among the *Productidæ*.

201. „ „ „ ? Interior of *ventral valve*, from a species from the Eifel.

202. „ „ Interior of *dorsal valve*, from a specimen from the Eifel.

203—205. Strophalosia excavata = genus *Orthothrix*, Geinitz.

206. „ *Goldfusii*, Munster, sp., showing the large area and deltidium.

207. „ *Morrisiana*, King. Interior of dorsal valve, enlarged; m, fragment of the *ventral valve*, to show the articulation of the hinge.

208. „ *Goldfusii*. Internal cast.

209, 210. „ *Morrisiana*, King. *f*, point of attachment.

211. „ *Gerardi*, King. (*Note.*—All the specimens from which the illustrations of *Strophalosia* have been drawn, were lent me by Professor King, and form part of the Collection of Queen's College, Galway.)

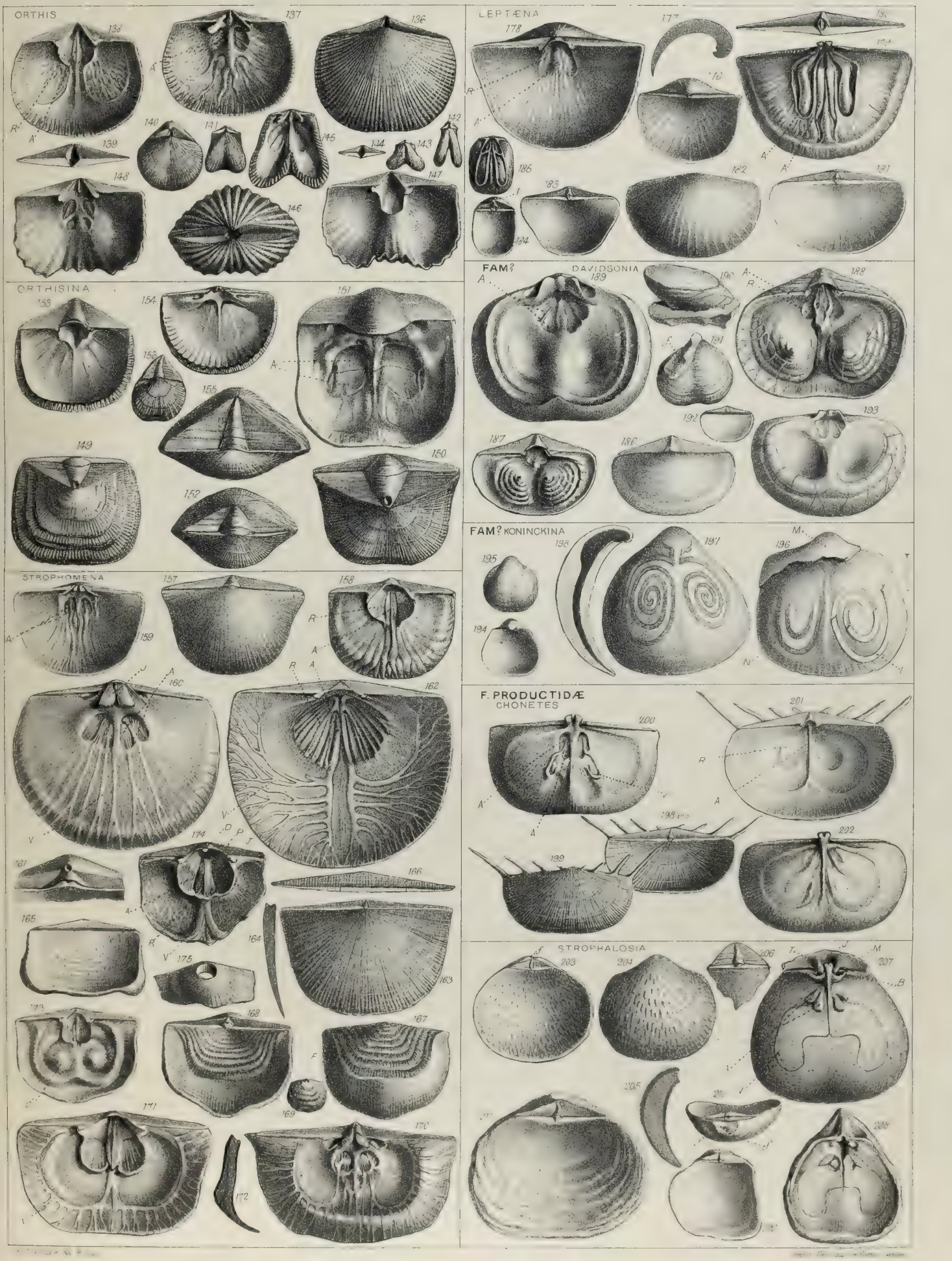

ORTHIS
LEPTÆNA
ORTHISINA
FAM? DAVIDSONIA
STROPHOMENA
FAM? KONINCKINA
F. PRODUCTIDÆ
CHONETES
STROPHALOSIA

PLATE IX.

The following Letters refer to the same parts and impressions in every figure.

A, *adductor muscles* (*add. longus*, Owen); R, *cardinal muscles* (*add. brevis* and *cardinalis*, Owen); P, *pedicle muscles* (*retractor sup.* and *inf.*, Owen); J, *cardinal process*; L, *loop*; T, *teeth*; B, *sockets*; D, *deltidium*; V, *vascular impressions*, &c.

Fig.

212, 213. AULOSTEGES WANGENHEIMI, Vern., sp. = (*Variabilis*, Helmersen).

214. „ „ Interior of *dorsal valve* (slightly enlarged).

215. „ „ Cardinal process, J, from a very remarkable specimen, published by Col. Helmersen. (Bull. Phys. Math., tab. vi, fig. 12.)

216. „ „ The same, from another specimen in my collection.

217. PRODUCTUS SEMIRETICULATUS. From a specimen in the collection of Professor King.

218. „ *punctatus*. Ventral valve, with portions of the spines preserved.

219. „ *horridus*. Interior of dorsal valve.

220. „ „ Interior of ventral valve.

221. „ *longispinus*. Interior of dorsal valve.

222, 223. „ *proboscideus*, Vern. From specimens in the collection of M. de Koninck.

224—226. CALCEOLA SANDALINA, from the Eifel.

227. „ „ Interior of *ventral valve*.

228. „ „ Interior of *dorsal valve*.

229. CRANIA BRATTENBURGENSIS (NUMMULO, Stoboeus).

230—232. „ *antiqua*, Def.

233. „ „ Interior of the ventral valve.

234. „ „ Interior of the upper or dorsal valve.

235, 236. „ *Ignabergensis*, Retzius.

237, 238. „ *anomala* (PATELLA *anomala*, Müller) = genus ORBICULA, Cuvier and Lamarck.

239. „ *Hagenovi*, De Koninck, MS.

240. „ „ Interior of lower or *ventral valve*, exhibiting two bosses, *h*, for attachment of sliding muscle?

241—243. *Spondylobus craniolaris*, M'Coy.

244, 245. *Pseudo-crania antiquissima*, Eichw. sp. Type of Professor M'Coy's genus.

246, 247. „ *divaricata*, M'Coy, sp.

248—250. DISCINA LAMELLOSA, Brod., sp.

251. „ „ Interior of lower or *ventral valve*.

252. „ „ Interior of upper or *dorsal valve*.

253—255. ? *Orbiculoidea elliptica*, Kut., sp. Genus *Schizotreta*, Kutorga.

256—258. *Trematis terminalis*, Emmons, sp. (enlarged) = *Orbicella*, D'Orb.

Fig.

259. *Trematis terminalis.* Fragment, showing the outward sculpture (*not punctation*).

260. „ „ A small specimen figured by Mr. Sharpe.

261—263. Siphonotreta unguiculata, Eichw., sp.

264. „ „ Interior of dorsal valve.

265. „ „ Interior of ventral valve.

266. „ *conoides,* Kut.

267, 268. „ *verrucosa,* Eichw.

269. „ *unguiculata.* Section from Kutorga's paper on the genus.

270. „ „ A spine enlarged.

271—273. *Acrotreta subconica,* Kut.

274, 275. „ „ Enlarged.

276, 277. Lingula anatina.

278. „ „ Interior of *ventral valve.*

279. „ „ Interior of *dorsal valve.*

280. Obolus apollinis, Eich. (ventral valve), genus *Ungula,* Pander; *Aulonotreta,* Kutorga.

281. „ „ *Dorsal valve.*

282. „ „ Interior of *dorsal valve,* from a specimen sent to me by Professor Kutorga.

283 & 285. „ „ Interior of the ventral valve, published in Professor Kutorga's 'Mémoir.'

284. „ „ Fragment of the interior of dorsal valve, in Professor Kutorga's 'Mémoir.'

F. FAM. DISCINIDÆ DISCINA
PRODUCTUS
TREMATIS
SIPHONOTRETA
Lacrotreta
F? CALCEOLA
CRANIADÆ CRANIA
F. LINGULIDÆ. LINGULA
OBOLUS

THE

PALÆONTOGRAPHICAL SOCIETY.

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MDCCCLIII.

DESCRIPTION

OF THE

FOSSIL REMAINS OF MOLLUSCA

FOUND IN THE

CHALK OF ENGLAND.

BY

DANIEL SHARPE, F.R.G. & L.S.

PART I.

CEPHALOPODA.

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INTRODUCTION.

The best general account of the Chalk Formation of England will be found in the 'Geology of England and Wales,' by Conybeare and Phillips, 1822, in which is embodied a detailed description of the Chalk Cliffs in the neighbourhood of Dover by Mr. W. Phillips, published in the fifth volume of the 'Transactions of the Geological Society.' The divisions of the Formation which Mr. Phillips has pointed out, are more minute than can be followed in the present Monograph, since few collectors attend to the precise part of the series from which their specimens are derived. I have, therefore, usually contented myself with referring specimens to one or other of the following great divisions of the Chalk, which are easily recognised, although they are not separated by any well-defined lines.

1. Upper Chalk; my specimens of which are principally from Norfolk, or from Gravesend and Northfleet: this division is rich in Organic Remains.

2. Middle Chalk, which contains but few Fossils: those examined are mostly from Kent, Surrey, Sussex, and the Isle of Wight.

3. Lower or Grey Chalk, containing numerous Fossils, especially Ammonites and Turrilites: the neighbourhood of Dover, and of Lewes, and the Isle of Wight furnish large supplies; many specimens have also been procured from the numerous Chalk-pits along the foot of the North Downs, and others have been obligingly sent from Devizes, by Mr. W. Cunnington.

4. The "Chloritic Marl" of the Isle of Wight, a bed of some six or eight feet thick at the base of the Chalk, is very rich in Organic Remains, with which I have been most liberally supplied from the rich Collection of Mr. S. Saxby, Jun., of Bonchurch. The "Chalk with Siliceous Grains," of Somersetshire, is probably on the same parallel as the "Chloritic Marl," and also contains abundance of Shells, of which a large collection formed at Chardstock has been most obligingly lent me by Mr. J. Wiest: these have the advantage of being far better preserved than is usual with the Chalk Fossils. I have also had the use of Collections from this bed, belonging to Mr. E. H. Bunbury and Mr. Morris.

Besides the gentlemen already mentioned, I am indebted for the loan of specimens to Mr. Baber, Mr. Bowerbank, Mr. Henry Catt, Mr. Faulkner, Mr. Flower, Mr. Hudson, Mr. J. G. Low, Mr. S. J. Mackie, Dr. Mantell, Mr. H. Taylor, and Mr. Wetherell, whose names will be frequently mentioned in the course of the work, together with those of others, who may be kind enough to lend me similar assistance. I have also to thank Mr. Morris most especially for his valuable assistance in determining many obscure species, and Mr. S. P. Woodward, for notes relating to specimens in the British Museum, and for many drawings of parts requiring particular accuracy.

In giving the generic characters of Fossil Shells, it seems unnecessary to add descriptions of the Animals supposed to have inhabited and formed them; since such descriptions must be more or less conjectural, and information on this head is amply and more fitly provided by writers on the recent branches of Natural History. The Palæontologist must be contented with descriptions of the shell only, such as were furnished by the earlier school of Conchologists. The student who desires information about the Molluscous inhabitants of recent Shells, should consult the 'History of British Mollusca and their Shells,' by Forbes and Hanley, and the 'Figures of Molluscous Animals' by Mrs. Gray, or he will find in the 'Rudimentary Treatise of Recent and Fossil Shells' by S. P. Woodward a large amount of information condensed into a small and most economical form.

FOSSIL REMAINS OF MOLLUSCA

FOUND IN THE CHALK.

CEPHALOPODA.

Belemnites, *Auctorum.*

Animal unknown, enclosing a straight elongated conical, or fusiform calcareous shell or *guard* more or less pointed below, and pierced above with a conical cavity or *alveolus*, in which is lodged the *phragmacone*, a hollow horny cone divided into chambers by nearly horizontal septa, which are traversed on the anterior or ventral margin by a siphuncle. Wall of the alveolus entire. Exterior of the shell marked, in many species, by a furrow down the front, and one down the middle of each side, but without any branching vascular impressions.

The above description includes all the parts of the Belemnites which have been found in the Chalk; but in some of the beds of the Oolitic series more perfect specimens are found, in which the phragmacone is produced far above the walls of the calcareous shell, and is provided with two elongated, slender, testaceous processes, proceeding from the dorso-lateral margins of its upper edge; and the whole body is invested with a thin testaceous or corneo-calcareous integument. For full descriptions of these interesting remains the reader is referred to the Memoirs of Professor Owen in the 'Philosophical Transactions of 1844,' and of Dr. Mantell in the volumes of the same work for 1848 and 1850, and to the 'Paléontologie Française, Terrains Jurassiques' of M. D'Orbigny.

M. D'Orbigny separated from the Belemnites those species which have a fissure down the anterior or ventral side of the alveolar cavity, and which are provided with two longitudinal depressions down the dorso-lateral portions of the shell, from which, in some species, proceed branching vascular impressions; to these he has given the name of *Belemnitella*.

1. Belemnites ultimus, *D'Orb.* Plate I, fig. 17.

Belemnites minimus, in part? *Lister.* Hist. Anim. Angliæ, tab. vii, fig. 32?
— Listeri, *Phillips.* Geology of Yorkshire, vol. i, tab. i, fig. 18?
— ultimus, *D'Orbigny.* Paléont. Franç. Terr. Cret., Supp., p. 24.

B. Testâ sub-cylindricâ, infernè rotundatâ, acuminatâ; supernè rotundato-quadratâ; anticè, lateraliterque lineâ impressâ leviter notatâ.

Shell sub-cylindrical, slightly flattened both on the front and sides of the upper part, rounded below, and tapering gradually to a blunt point; with a slight furrow down the upper part in front, and a slight furrow down the upper part of the middle of each side; opening oval.

Length, 2 inches; greatest breadth, $\frac{2}{10}$ths of an inch.

Found by Mr. Saxby, in the Chloritic Marl of Bonchurch, in the Isle of Wight; found also in the Red Chalk of Yorkshire, and in the Gault of Folkstone.

This species is usually confounded with *Belemnites minimus* of the Gault, from which it is to be distinguished by a more cylindrical form, the slightly squared oval opening, and shortness of its lateral furrows. *B. minimus* on the contrary is spindle-shaped, with a round opening, and a double line impressed on each side, which reaches nearly to the point.

Professor Phillips first pointed out the necessity of separating the two species ('Geol. Yorksh.,' vol. i, p. 46), and called this one *B. Listeri*, although that name had previously been applied by Dr. Mantell to the other species. Lister undoubtedly had the two species before him when he wrote; but his name having been since restricted by all authors to the common Gault species, which has been called indiscriminately *B. minimus* and *B. Listeri*, it would increase the confusion to apply either of those names to this species, which may therefore pass under M. D'Orbigny's name of *B. ultimus*.

Plate I, fig. 17, *a*, *b*, *c*. Three views of Mr. Saxby's specimen, from the Chloritic Marl of Bonchurch: the point having been worn away, its outline is restored from another specimen.

Belemnitella, *D'Orbigny*.

Animal unknown, enclosing a straight, elongated, conical, or fusiform calcareous shell or *guard*, more or less pointed below, and pierced above with a conical cavity or *alveolus*, in which is lodged the *phragmacone*, a hollow horny cone, divided into chambers by nearly horizontal septa, which are perforated on the anterior or ventral margin by a siphuncle. Wall of the alveolus divided on the anterior side by a perpendicular slit, which remains open above, but is gradually closed below, where its place is marked by a groove on the outside of the shell, and a corresponding groove on the inside of the alveolus. Back of the exterior of the shell marked by two longitudinal depressions, which in some species are connected with complicated vascular impressions.

The remains of *Belemnitella* hitherto found in the Chalk, in this country, are limited to the calcareous shell; in addition to which portions of the phragmacone are preserved in the specimens of *B. mucronata* found in the Cretaceous Sandstone of Maestricht and Ciply.

The genus *Belemnitella* was separated from *Belemnites* by M. D'Orbigny, on account of the slit down the front of the alveolus, and the vascular impressions on the back and sides of the shell, which are wanting in *Belemnites*; the latter character is most strongly developed in *B. mucronata* and *B. quadrata*, and but faintly seen in *B. lanceolata* and *B. plena*. These characters seem a slight foundation for a separate genus; but the division has been generally adopted. All the Belemnitellæ, yet known, belong to the Chalk.

The Belemnitellæ may be divided into two sections, depending on the form and lining of the alveolar cavity: in *B. mucronata* and *B. lanceolata* the alveolus is a regular cone, with a rounded base, of which the apex forms an angle of about 20 degrees; the cavity is lined by a smooth continuous shelly layer, which in the fossils is denser, and less crystalline than the rest of the shell; this cavity is filled by the phragmacone, and is slightly marked by the edges of the septa.

In *B. quadrata* the lower part of the cavity for about one third of an inch is in the form of a cone, with a round base, of which the apex has an angle of about 20°; this is lined with a smooth shelly layer, and was evidently destined to receive the phragmacone. The cavity then widens out suddenly, and becomes nearly square; this upper angular part has no special lining, but is rough, with irregular rings marking the growth of the shell; the anterior slit reaches a little way into the lower part of the cavity. It has been suggested, that the upper angular part of the cavity may be due to decay; but its form is too constant and regular to be so explained.

The Swedish species *B. subventricosa* of Wahlenberg (*B. mamillatus*, Nills., *B. scaniæ*, Blainv.) has a cavity of analogous form to *B. quadrata*, with an irregularly triangular aperture above. M. König figured this species under the name of *Paxillus belemnoideus* (Icones, No. 218), apparently regarding its peculiar form of cavity as a sufficient generic character. But, as at present, we do not know the form of the phragmacone of either of these species, we cannot estimate the importance of the difference in the form of the cavity.

The vascular impressions are very differently developed in the different species of Belemnitella; they all have two depressions which extend down the sides of the posterior part; at the edge of the cavity these depressions are nearly as broad as the space between them, they diverge slightly and become narrower in their course downwards, and terminate near the apex of the shell, almost as near to the anterior as to the posterior side. These two depressions are usually all that we see of the vascular markings on *B. lanceolata* and *B. plena*, and on worn specimens of the other species; but on well-preserved specimens of *B. mucronata* and *B. quadrata* they are bounded on each side by an impressed line, from which spread off a number of branches, dividing and subdividing with great complication, which cover the sides and front of the shell.

Casts of the alveolar cavity of Belemnitellæ are frequently found in the flint of the Upper Chalk, which sometimes show more clearly the form of the cavity than can be seen in the shells themselves; the two woodcuts A and B are copied with Dr. Mantell's permission, from the second edition of his 'Geological Excursions round the Isle of Wight,' p. 440;

the specimen they represent was found in the Chalk near Ventnor, and is in the Cabinet of Mr. S. H. Beckles. Fig. B shows the upper part of one side of the *phragmacone* apparently complete; the upper transverse lines are too sinuous to represent the edges of the septa, which, as far as we know them, are nearly horizontal. Perhaps, the lower parallel and nearly horizontal lines may mark the edges of the septa, and the upper waving lines may indicate the growth of the margin of the phragmacone, which seems to have been furnished with two lateral processes.

In fig. A, the cast displays very clearly the complicated groove running down the back of the alveolar cavity.

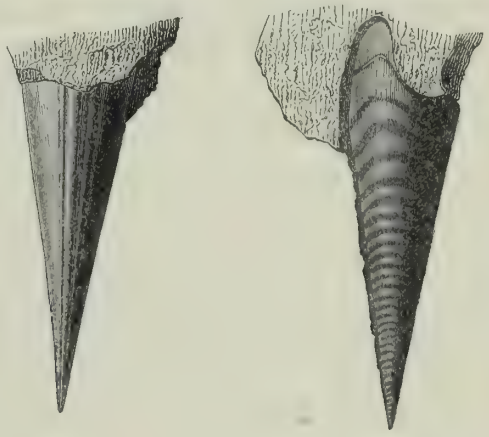


Fig. A Fig. B

1. Belemnitella mucronata, *Schlotheim*, Sp. Plate I, figs. 1, 2, and 3.

Belemnites, 1ª species: *Breyn*, de Belemnitis, figs. 1—6.
Belemnites mucronatus, *Schlotheim*. Petref., p. 47, No. 4.
— — *Mantell*. Sussex, t. xvi, fig. 1.
— — *Nilsson*. Petrif. Suec., t. ii, fig. 1.
— — *Sowerby*. Min. Conch., t. 600, figs. 2 and 4.
Belemnites electrinus, *Miller*. Geol. Tr., 2d series, vol. ii, t. viii, figs. 18—21.
Actinocamax verus? *Miller*. Loc. cit., t. ix, figs. 17 and 18.
Belemnitella mucronata, *D'Orbigny*. Palæont. Franç. Terr. Crét., t. vii.
— — Geol. of Russia and the Ural Mountains, vol. ii, t. xliii, figs. 1 and 4, not figs. 2 and 3.

B. Testá subcylindricá, impressionibus duabus vascularibus ramosis notatá, anticè fissuratá, posticè obtusá mucronatá; aperturá subrotundá; alveolo conico excentrico.

Shell elongated, subcylindrical, widening very slightly above, obtuse below, with a distinct rounded point. Opening circular. Alveolus forming a regular hollow cone, with a round base, and an apex of 18° to 20°, which is considerably nearer to the anterior than to the posterior side of the shell; the position of the septa may be faintly traced on the lining of the alveolus. The fissure extends to within half an inch of the apex of the cavity, but may be traced to the bottom, on the inside, by a continued depression; another

impressed line runs down the dorsal side of the cavity. The vascular impressions are usually well-marked, and cover a large part of the surface, they branch off from a pair of double lines, which commence near together on the two sides of the back, and separate gradually as they extend downwards to near the point.

B. mucronata is nearly allied to *B. lanceolata;* it may be recognised by a more cylindrical form with a distinct mucro, by its well-marked vascular impressions, and by the eccentricity of the alveolar cavity.

In a fine specimen from Norwich, measuring $3\frac{1}{2}$ inches in length, the greatest diameter is $\frac{5}{8}$ths of an inch, and the fissure extends externally $\frac{3}{4}$ths of an inch. But all the specimens found in this country are broken off at the top, where the walls of the alveolus are very thin. They are found in the Maestrict Sandstone with the upper part much better preserved, the whole being 6 inches long, the alveolus spreading out at top to a width of above an inch, and with an external fissure $2\frac{1}{2}$ inches long.

Found everywhere in the Upper Chalk of the South of England, and particularly abundant in Norfolk. It is also found in the Upper Chalk of France, Germany, Belgium, Sweden, and Russia. Also in the Cretaceous Sands of Maestrict and Ciply near Mons, and at Faxoe in Denmark.

2. BELEMNITELLA LANCEOLATA, *Schlotheim*, Sp. Plate I, figs. 4—6.

BELEMNITES, 2ª species: *Breyn*, DE BELEMNITIS, figs. 7—10.
— LANCEOLATUS, *Schlotheim*. Petrefactenkunde, p. 49, No. 8.
— MUCRONATUS, *Brong.* and *Cuvier*, t. iii, fig. 1?
— — *Blainville*. Belemnites, t. i, fig. 12.
— — *Sowerby*. Min. Conch., t. 600, fig. 1, excluding all the other figures.
— — *Woodward*. Geol. Norfolk, p. 49.
BELEMNITELLA MUCRONATA, var. FUSIFORME, *D'Orbigny*. Geol. of Russia and the Ural Mountains, vol. ii, t. xliii, figs. 2 and 3.

B. Testâ elongatâ, fusiformi; anticè subdilatatâ, fissuratâ; posticè acuminatâ; aperturâ subrotundâ; alveolo conico, centrali.

Shell elongated, fusiform, widening at the opening, then somewhat contracted, and again enlarging to about two thirds its length, whence it gradually tapers off to a point. Alveolus slightly oval above, circular below, forming a regular hollow cone, of which the apex with an angle of 20° is nearly on the central axis of the shell; the alveolar cavity is lined by a distinct shelly layer, faintly marked by numerous horizontal rings, very near each other in the lower part, and becoming gradually more distant upwards, and is slit down its anterior side by a fissure which extends within nearly to the apex of the cavity; but is partially closed on the outside by the new layers of shell, which in old specimens cover about half an inch of the lower part of the original fissure. Another

impressed line runs down the back of the alveolar cavity. Vascular impressions apparently resembling those of *B. mucronata* are faintly marked and frequently obliterated.

This Belemnite, which was well distinguished by the earlier writers on the subject, has been confounded by all later authors with *B. mucronata*, from which it is distinguished externally, by its less cylindrical form, and fainter vascular impressions; and internally, by the central position, and more circular section of the alveolus.

Breyn, one of the earliest writers who made an approach towards the true nature of Belemnites, distinguished the present species from *B. mucronata* without naming either, and has given good figures of both, as Species 1 and 2. He was followed by Schlotheim, who, referring to Breyn's figures, names his 1st species *B. mucronatus*, and his 2d species *B. lanceolatus*, which names we must adopt, on the principle of priority; an unlucky remark of Schlotheim that, perhaps, Montfort's *Hibolithus hastatus* might prove a variety of his *B. lanceolatus*, has led both D'Orbigny and Bronn to throw aside Schlotheim's name *B. lanceolatus*, as a synonym of *B. hastatus*; the slightest reference to Breyn would have saved them from this error, as that author's 2d species belongs clearly to the Genus *Belemnitella*, the slit down the front of the alveolar cavity being well shown in the figures, and clearly described in the text.

Miller was probably aware of the difference between the two species, since finding this one figured by Blainville as *B. mucronatus*, he gave to the original *B. mucronatus* the new name of *B. electrinus*. Woodward living in Norfolk, where the two species are abundant, was well acquainted with both, and distinguishes them clearly in his Catalogue, as *B. mucronatus* tapering off to a point, and *B. electrinus* obtuse, with a mammillated point.

Sowerby, Min. Con., t. 600, threw the two species together, figuring them both under the name of *B. mucronatus*, and the same is done by M. D'Orbigny, in the second volume of the 'Geol. of Russia, where they are well figured as *Belemnitella mucronata*, variété *fusiforme* and variété *renflée*; but in the 'Paléontologie Française' we have only the true *B. mucronata*, well figured and described, without any allusion to the other form.

3. Belemnitella quadrata, *Defrance*, Sp. Plate I, figs. 7—11.

Belemnites quadratus, *Blainville*. Belemnites, t. i, fig. 9.
— granulatus, *Sowerby*. Min. Conch., t. 600, figs. 3 and 5.
Belemnon pustulatum, *Kœnig*. Icones Foss. Sect., No. 216.
Belemnitella quadrata, *D'Orbigny*. Paléont. Franç. Terr. Crét., t. vi, figs. 5—10.

B. testâ subcylindricâ, granulatâ; apice obtusiusculo mucronato; aperturâ subquadratâ: alveolo infernè rotundato conico, supernè expanso subquadrato.

Shell nearly cylindrical, rounded towards the apex, which ends in a distinct point; alveolus wide, and four-sided above; round and conical below, with a short slit on the anterior side, which reaches into the rounded part of the cavity; surface almost entirely

covered with small granulations; vascular impressions strongly marked in the young shell, but somewhat concealed by the granulations in the full-grown shell.

The external form of *B. quadrata* is nearly the same as that of some varieties of *B. mucronata;* so that worn specimens which have lost both their outer surface and the upper part of the alveolus may easily be confounded; and there has been confusion in consequence in the synonyms. But it is well distinguished both by the granulations of the surface and the square opening.

The lower part of the alveolar cavity, lined with a distinct, smooth, shelly layer, is of the form of a rounded cone, about a quarter of an inch deep; above this, the cavity suddenly widens out, and changes its character; it is irregularly four-sided, and the surface has no special lining, but is roughened by the rings of growth of the shell. The fissure is shallow, and reaches to the top of the lower division of the cavity. Unfortunately, the Phragmacone of this species is not known; it would probably correspond in form with the lower part of the cavity only.

Length, $2\frac{1}{2}$ inches; greatest breadth, $\frac{4}{10}$ths of an inch; cavity, $\frac{3}{8}$ths of an inch, of which the broader part occupies $\frac{1}{8}$th, and the narrow rounded cone, $\frac{1}{4}$th of an inch.

B. quadrata is found in the middle beds of the chalk of the counties of Kent, Surrey, and Sussex, but is no where a common species. It has also been found in the upper chalk of Northfleet.

It occurs, according to M. D'Orbigny, in the white chalk of Rheims in France, and of Visé in Belgium.

4. Belemnitella plena, *Blainv.*, Sp. Plate I, figs. 12—16.

Breyn. De Belemnitis, fig. 15?
Belemnites plenus, *Blainville.* Belemnites, t. i, fig. 6.
— lanceolatus, *Sowerby.* Min. Conch., t. 600, figs. 8 and 9.
— — *Geinitz.* Quadersansteingebirge, t. vi, figs. 3—5.
Belemnitella vera, *D'Orbigny.* Paléont. Franç. Terr. Crét., Suppt., t. ii.

B. testâ elongatâ fusiformi, sublævi, supernè rotundato-trigonâ canaliculatâ, medio rotundatâ dilatatâ; apice acuminato.

Shell elongated; when young cylindrical, with a tapering point; when full-grown fusiform, swelling out below the middle, and tapering below to a point; front marked with a slight furrow; a broad longitudinal depression on each side of the back, giving somewhat of a three-sided form to the upper part of the shell. All the specimens have the walls of the alveolar cavity broken off, leaving usually a projecting conical end, in the centre of which the point of the alveolus may be distinguished.

The specimen, fig. 12, belonging to Mr. Morris, has fortunately the lower part of the cavity preserved, but not enough to show any trace of a fissure; therefore the supposed fissure figured by M. D'Orbigny, pl. ii, figs. 2, 4, and 7, in a more truncated specimen,

must be due to decay. Geinitz has figured the lower portion of the Phragmacone, but his figure is hardly intelligible.

Although the specimens of this Belemnite are found truncated at different attitudes, and the fracture is either nearly flat or more or less conical, there are common characters in the broken ends of all, which are without doubt connected with the manner of growth of the shell. There are usually two more prominent ridges on each side, and three slighter ridges on the back. The sides of the angular cone thus formed, appear to have some analogy with the angular opening of *B. quadrata*, and render it probable that *B. lanceolata* will be found to belong to the same division of the genus as that species.

M. D'Orbigny has named this species *B. vera*, on the supposition that it is the *Actinocamax verus* of Miller; but the description given by that author proves that, as Mr. Sowerby correctly observed in the 'Mineral Conchology,' *A. verus* is a worn specimen of *B. mucronata*. Miller describes his species as having "two longitudinal, towards the apex branching, impressions of blood-vessels." He also states that it is often found in flints. Both the description and the placing in it in the chalk with flints are decisive against regarding it as *B. lanceolata*. Every species of Belemnite, when rolled and worn at the top, may present a form similar to that of Miller's figure 17; and the *B. mucronata* especially, in decaying peels off in concentric layers, as in his figures 11, 12, and 13, 'Geological Transactions,' 2d series, vol. ii, pl. 9. It is probable that when describing *Articonamax verus*, Miller may have had before him worn specimens of several species of Belemnite. Such names founded on misconception had better be allowed to drop. But in this instance, as Miller's description applies to *B. mucronata*, there is no room for his name of *A. verus*. The name first in point of priority is *B. plenus* of Blainville, which has consequently been adopted. Sowerby's name, *B. lanceolatus*, is not only posterior to Blainville, but had been previously applied by Schlotheim to another species.

Length, $3\frac{1}{2}$ inches; greatest breadth, $\frac{5}{8}$ths of an inch.

Common throughout the grey chalk of the South of England, and found in the lower beds of the chalk in Belgium, Germany, and the North of France.

Nautilus, *Linn.*

Shell discoidal, spiral, chambered, compressed or ventricose, with contiguous whorls regularly convoluted on the same plane, the last partially or entirely concealing the previous whorl; chambers separated by transverse, concave septa, with simple sinuous margins, and traversed near their centre by a continuous siphuncle; the last chamber large, and capable of containing the animal.

1. Nautilus lævigatus, *D'Orb.* Plate II, figs. 1 and 2.

Nautilus lævigatus, *D'Orbigny.* Paléont. Franç. Terr. Crét., pl. xvii.

N. testâ globosâ, lævi, umbilico minimo aut nullo; aperturâ semi-circulari; septis parum arcuatis; siphunculo subcentrali.

Shell globose, smooth, with the back and sides uniformly rounded, and a very faint line running along the middle of the back; umbilicus very small and entirely concealed in the inner whorls; septa slightly arched, with nearly straight margins; siphuncle a little in front of the centre; mouth nearly semi-circular, but rather wider than high, deeply indented by the preceding whorl, with a broad shallow mesial sinus.

This shell attains a large size. A specimen from Brighton measures $4\frac{1}{2}$ inches in diameter and $3\frac{1}{2}$ inches in breadth.

N. lævigatus is one of the commonest of the cretaceous species, and is found throughout the whole range of the Chalk, viz., in the Upper Chalk near Brighton; in the Middle Chalk near Maidstone, Hemel Hempstead, and Tring; in the Grey Chalk at Dover and Lewes; in the Chloritic Marl of Bonchurch in the Isle of Wight; and in the Chalk with siliceous grains at Chardstock and on the coast of Dorsetshire. It is found in France in the Upper Green Sand, the Lower and Middle Chalk.

The only cretaceous species of *Nautilus* for which this could be mistaken, are *N. Bouchardianus*, D'Orb. and *N. simplex*, Sow. (*N. Clementinus?* D'Orb.) both of which have a more marked umbilicus, and a depression on the ventral margin of the septa; the latter is also a less globose shell, and has the siphuncle nearer the ventral than the dorsal margin.

2. Nautilus expansus, *Sow.* Plate II, figs. 3—5.

Nautilus expansus, *Sowerby.* Min. Conch., t. 458, fig. 1.
— Archiacianus, *D'Orbigny.* Paléont. Franç. Terr. Crét., t. xxi.

N. testâ inflatâ, lateraliter compressiusculâ, umbilicatâ, subtiliter striatâ; umbilico sub-carinato; aperturâ latâ sub-pentagonâ; septis undulatis; siphunculo sub-centrali.

Shell globose, with sloping slightly flattened sides and a sharply defined umbilicus; surface elegantly marked by fine sharp lines of growth, which are deeply incurved in front; whorls increasing rapidly in size and nearly concealing the preceding whorls; septa very flexuous; siphuncle within the centre of the septum; mouth about as broad as high, somewhat pentangular, rounded in front, with nearly straight sloping sides deeply indented by the inner whorl, and with a deep, broad, rounded sinus.

Diameter $2\frac{1}{4}$ inches, breadth $1\frac{1}{2}$ inch.

N. expansus is confined to the lowest bed of the Chalk; it is rare in the Chalk Marl of Hamsey near Lewes, and in the Chloritic Marl of Bonchurch in the Isle of Wight; and

abundant in the Chalk with siliceous grains at Chaldon and Man-of-War Cove in Dorsetshire, and Chardstock in Somersetshire. M. D'Orbigny cites it from the *Craie Chloritée* of Mount Ste. Catherine, near Rouen.

The figure in the 'Mineral Conchology' is taken from a specimen somewhat expanded at the mouth by pressure; but the form of the umbilicus and the fine sharp striæ leave no doubt of its identity with *N. Archiacianus*, D'Orb.

3. Nautilus Deslongchampsianus, *D'Orb.* Plate III, figs. 1 and 2.

Nautilus elegans, part. *Mantell.* Fossils of the South Downs, t. xxi, fig. 8.
— Deslongchampsianus, *D'Orbigny.* Paléont. Franç. Terr. Crét., t. xx.

N. testâ sub-globosâ, umbilicatâ, transversim costatâ et longitudinaliter striatâ; umbilico carinato; costis elatis flexuosis; striis tenuibus decussatis; aperturâ semi-ovali.

Shell sub-globose, umbilicated, elegantly ornamented with sharp elevated transverse flexuous ribs, which are usually crossed by thin longitudinal lines; the latter are often obliterated in ill-preserved casts; the ribs rise within the umbilicus and are bent at a sharp angle over its carinated margin; they then sweep forward in a bold curve, and form a deep sinus on the back, where they occasionally divide into two; the ribs are steep on their front side and sloping behind, thus forming a series of steps on the surface; the edge of the umbilicus is angular or raised into a slight keel.

The longitudinal lines are very prominent in some specimens, but can hardly be discerned in others; but the species can always be distinguished by the form of the ribs, the deep and angular umbilicus. It is common in the Grey Chalk of Lewes, Dover, the Isle of Wight, &c., and in the Chalk with siliceous grains of Chardstock, Somersetshire. In France it abounds in the *Craie Chloritée* of Mount Ste. Catherine, near Rouen.

Diameter $2\frac{1}{2}$ inches, breadth $1\frac{3}{4}$ inch.

4. Nautilus elegans, *Sowerby.* Plate III, fig. 3; and Plate IV, fig. 1.

Nautilus elegans. *Sowerby.* Min. Con., t. 116.
— — *Mantell.* Fossils of the South Downs, t. xx, fig. 1.
— — *D'Orbigny.* Paléont. Franç. Terr. Crét., t. xix.

N. testa globosâ, costatâ; costis æqualibus, rotundatis, sub-flexuosis; aperturâ semicirculari; siphunculo inter dorsum et septi centrum posito; umbilico minimo.

Shell globose, uniformly rounded, ribbed; umbilicus slightly marked on the outer but entirely concealed in the inner whorls; ribs equal, rounded, and regular, bending in a simple curve from the umbilicus to the back, where they form a broad shallow sinus; aperture semi-oval, a little higher than broad, deeply indented by the preceding whorl. Siphuncle placed about half way between the centre of the septum and the back.

Diameter $6\frac{1}{2}$ inches, breadth 5 inches. A gigantic specimen, sent me by Mr. Tyler from Hamsey near Lewes, reaches $11\frac{1}{2}$ inches in its greatest diameter, and the ribbing continues of about the same breadth throughout. This species is common in the Grey Chalk of the South of England and in the lower beds of the Chalk of France.

For many years all the ribbed Nautili found in the Chalk were confounded together under the name of *N. elegans*. Sowerby separated *N. radiatus*. But we owe to M. D'Orbigny the clear distinction of the different species, which may be known as follows:

N. elegans is the most globose shell of the group, and has the smallest umbilicus; it is also to be known by the position of the siphuncle between the back and the centre of the septum.

N. pseudo-elegans is rather less globose than the preceding, has a more distinct umbilicus, broader and fewer ribs, and the siphuncle between the ventral margin and the centre of the septum; the two species are so much alike that the only character to be relied on for distinguishing them is the position of the siphuncle.

N. radiatus is easily recognised by a flatter form, with sloping sides, large umbilicus and deep septa with a sinuous margin; the siphuncle occupies nearly the same position as in the last; but there is also a marked depression of the septum close to the ventral margin, which is not found in either *N. elegans* or *pseudo-elegans*.

N. Neocomiensis has flat and nearly parallel sides, a very large umbilicus, the ribs much bent on the back, the siphuncle between the centre and the ventral margin, but without the ventral depression of the septum.

N. Deslongchampsianus is easily distinguished by the cross longitudinal ribs, and even if these are lost, by the elevated edge of the umbilicus.

In all these species the ribbing is only seen in the exposed portion of the outer whorl, being concealed within by a layer of shell formed by the ventral fold of the mantle. Thus specimens which have lost the outer whorl may appear partially or entirely smooth.

5. Nautilus pseudo-elegans, *D'Orb.* Plate IV, fig. 2.

Nautilus pseudo-elegans, *D'Orbigny.* Paléont. Franç. Terr. Crét., t. viii and ix.

N. Testâ ovatâ, subcompressâ, costatâ, umbilicatâ; costis æqualibus, rotundatis, flexuosis; umbilico parvo; aperturâ semi-ovali; septis arcuatis; siphunculo inter ventrem et septi centrum posito.

Shell ovate, ribbed, with a small well-marked umbilicus; ribs broad, rounded, and flexuous, with a deep sinus on the back; aperture semi-oval, higher than broad, deeply indented by the preceding whorl; septa arched, with the siphuncle between the centre and the ventral margin.

Diameter 7 inches, breadth 4 inches.

Common in the Grey Chalk of Lewes and elsewhere. Professor E. Forbes appears to

have seen specimens from the Lower Green Sand,* to which Formation M. D'Orbigny states that it is confined in France.

M. D'Orbigny separated this species from *N. elegans*, which it closely resembles; it is less globose, has broader and more flexuous ribs, deeper septa, and a more distinct umbilicus; but it is best distinguished by the position of the siphuncle, which in this species is situated between the inner margin and the centre of the septum, and in *N. elegans* is nearer to the back. Notwithstanding this character, most writers seem disposed to throw them together.

6. Nautilus radiatus, *Sow.* Plate V, figs. 1 and 2.

Nautilus radiatus, *Sowerby*. Min. Conch., t. 356.
— — *D'Orbigny*. Paléont. Franç. Terr. Cret., t. xiv.

N. Testâ ovatâ, subcompressâ, costatâ, latè umbilicatâ; costis latis, æqualibus, flexuosis; septis arcuatis, margine flexuosis, ad ventrem depressis; siphunculo inter ventrem et septorum centrum posito.

Shell gibbose, with sloping flattish sides and rounded back, ornamented with broad flexuous equal ribs; septa, with a flexuous margin low at the sides and produced at the back, marked with a deep depression close to the edge of the preceding whorl; siphuncle between the centre and the ventral margin; aperture semi-oval, cousiderably higher than broad, slightly indented by the preceding whorl; umbilicus large, exposing all the inner whorls.†

Diameter 7 inches, breadth 4 inches.

Common in the Chalk with siliceous grains at Chardstock in Somersetshire, and also found in the Grey Chalk near Dover, Guildford, &c. In Professor Forbes's 'List of Lower Green Sand Fossils' it is mentioned as found at Atherfield and Sandgate, and M. D'Orbigny quotes it in France from the Lower Chalk, the Upper and Lower Green Sands.

N. radiatus is easily distinguished from *N. pseudo-elegans* by its large umbilicus, the flexuous margin, and the ventral depression of the septa; the latter character separates it also from *N. Neocomiensis*.

* Journal of Geol. Society, vol. i, p. 353.

† The ribs begin to show themselves when the shell is about one inch in diameter; previously, it is ornamented with fine sharp elevated lines marking the growth of the shell, crossed by finer longitudinal lines, as seen in fig. 2; a similar ornament is found in many species of Nautilus when young.

7. Nautilus Neocomiensis, *D'Orb.* Plate V, fig. 3.

Nautilus Neocomiensis, *D'Orbigny.* Paléont. Franç. Terr. Crét., t. xi.

N. Testâ inflatâ, lateraliter compressâ, latè umbilicatâ, costatâ; costis latis flexuosis, dorso sub-angulatis; septis margine paulum flexuosis; siphunculo inter ventrem et septorum centrum posito.

Shell gibbous, with flattened sides and a broad umbilicus, ornamented with rounded flexuous ribs, which are less marked at the sides but broad and large on the back, where they bend so rapidly as to form an almost angular sinus; the sides of the whorls being nearly parallel, and the whorls increasing but slowly in breadth, the whole shell has a flattened form by which it is easily recognised; margins of the septa slightly curved; siphuncle half-way between the centre and the inner margin of the septa.

We have only seen one small specimen from the Grey Chalk, which we can refer to this species; it is from Urchfont near Devizes, in the Collection of Mr. Cunnington, and is 2 inches in its greatest diameter and $1\frac{1}{4}$ inch in breadth; although a good deal broken, it shows all the peculiar characters of the species. This species is more common in the Lower Green Sand of Dorking, Atherfield, Sandgate, &c., where it sometimes reaches above 7 inches in diameter. M. D'Orbigny quotes it as common in the lower beds of the Middle Division of the Neocomian Formation in France.

The only species with which this can be confounded is *N. radiatus,* from which it may be known by its flatter form, larger umbilicus, septa less flexuous and without any depression at the ventral margin, and the more angular sinus of the ribs on the back.

8. Nautilus undulatus, *Sow.* Plate V, fig. 4.

Nautilus undulatus, *Sowerby.* Mineral Conchology, t. xl.

N. Testâ gibbosâ; juniore lævi, lateribus sub-compressis, dorso lato-rotundato; adultâ lateraliter expansâ, transversim undulato-costatâ; septorum margine flexuoso; siphunculo sub-ventrali; aperturâ semi-ovali; umbilico clauso.

Shell when young, smooth and regular, with flattish sides, a broad rounded back, and semi-oval aperture; when about two inches in diameter, it enlarges rapidly, expands at the sides, and begins to undulate over the back; when adult, the whole shell is ribbed in broad, coarse undulations, which are deepest on the back, but ill-defined on the sides; back marked by a line at first slightly raised, which in the old shell forms a ridge between the undulations; umbilicus covered; septa flexuous; siphuncle near the ventral margin.

We have only seen one specimen of this species from the Chalk, which was found by Mr. Wiest in the Chalk with siliceous grains of Chardstock; it is a young shell,

$2\frac{1}{2}$ inches in diameter and $1\frac{1}{2}$ inch broad at the mouth; it is interesting, as it shows the change from the neatness of the young shell to the coarse irregular wavy form of the adult.

This shell is found more plentifully in the upper part of the Lower Green Sand, where it reaches a diameter of 4 or 5 inches. M. D'Orbigny has not met with it in France.

When young, *N. undulatus* has considerable resemblance to *N. largilliertianus*, from which it is distinguished by its closed umbilicus; in its undulated stage it cannot be confounded with any other species.

9. Nautilus largilliertianus, *D'Orb.* Plate VI, figs. 1 and 2.

Nautilus largilliertianus, *D'Orbigny.* Paléont. Franç. Terr. Crét., t. xviii.

N. Testâ discoideâ, compressâ, umbilicatâ, delicatim striatâ; lateribus complanatis; dorso planiusculo, in medio lineato; umbilico magno, margine declivi; aperturâ ovato-rhomboideâ; septorum marginibus flexuosissimus; siphunculo sub-ventrali.

Shell discoidal, with fine lines of growth which are not seen in the cast; with flat sides and a somewhat flattened back, marked with a slightly raised mesial line; umbilicus large, with perpendicular sides, exposing all the inner whorls; aperture rhomboidal with rounded corners, deeply indented by the preceding whorl; margin of the septa very flexuous; siphuncle very near to the inner margin. In old shells the back is slightly undulated.

Diameter 2 inches, breadth $\frac{7}{8}$ths of an inch.

This elegant shell is easily distinguished from the other Cretaceous species by the rhomboidal form of the whorls, well-defined umbilicus, and flexuous septa; the striæ are only seen in very well-preserved specimens.

Found occasionally in the Grey Chalk at Lewes, and in the Chloritic Marl of the Isle of Wight; more common in the Chalk with siliceous grains of Chardstock and Chaldon.

M. D'Orbigny cites it as common in the Lower Chalk of the North of France.

10. Nautilus fleuriausianus, *D'Orb.* Plate VI, fig. 3.

Nautilus fleuriausianus, *D'Orbigny.* Paléont. Franç. Terr. Crét., t. xv.
Nautilus Sowerbyanus? *D'Orbigny.* Ibid., t. xvi.

N. Testâ lateribus compressâ, dorso rotundatâ, sub-umbilicatâ, lævi; aperturâ semi-ovatâ; septorum marginibus flexuosis; umbilico minimo; siphunculo sub-centrali.

Shell with sloping and somewhat flattened sides and rounded back, smooth, with a very small umbilicus; mouth semi-oval, higher than wide, deeply indented by the pre-

ceding whorl; margin of the septa flexuous; siphuncle sub-central, but rather nearer to the ventral than to the dorsal margin.

Diameter $3\frac{1}{2}$ inches, breadth 2 inches.

Found occasionally in the Chalk with siliceous grains, at Chardstock. M. D'Orbigny quotes it as common in beds of the same age in the North and West of France.

Our specimens have a rounder back and more flexuous septa than M. D'Orbigny's figure of *N. fleuriausianus*, in which characters they approach his figure of *N. Sowerbyanus*, from which they are distinguished by a smaller umbilicus. I am inclined to regard them both as one species, and have adopted the name of *N. fleuriausianus*, as the other would be liable to confusion with the *N. Sowerbii* of the 'Mineral Conchology.' I have only seen casts of the *N. fleuriausianus*, which do not show the siphunculus, and have described its position upon the authority of M. D'Orbigny's figure and description.

11. Nautilus Fittoni, *Sharpe*. Plate VI, fig. 4.

Nautilus compressus, *Fitton*. Trans. Geol. Soc., 2d series, vol. iv, pp. 203 and 367, Note.

N. testâ lævi, compressâ, complanatâ, umbilicatâ; lateribus planis, obliquis; dorso angusto, rotundato, in medio lineato; umbilico magno; aperturâ truncato-sagittatâ, apicè rotundatâ; siphunculo sub-ventrali; septorum marginibus flexuosissimis.

Shell discoidal, smooth; sides flat, sloping; back narrow and rounded, marked with a faint line along the middle; umbilicus large, allowing the inner whorls to be seen, its walls nearly perpendicular; aperture sagittate with the angles rounded off; septa with a very flexuous margin; siphuncle very near the lower margin of the whorls.

Diameter about 3 inches, breadth 1 inch.

This shell has a good deal of resemblance to *N. Saxbii* of Morris, in general form, proportions, and flexure of the septa; but differs from that species in its rounded back.

This species was first noticed by Dr. Fitton in the Upper Green Sand, Western Lines Isle of Wight, and placed in the Museum of the Geological Society; it is called in his lists *N. compressus*, which name had unfortunately been previously applied to another species. It has since been found by Mr. Wiest in the Chalk with siliceous grains of Chardstock; both of the specimens are imperfect. It is named after the original discoverer.

Ammonites, *Bruguière*.

Animal unknown: shell chambered, discoidal, compressed or ventricose, spiral, with contiguous whorls regularly convoluted on the same plane, the last partially or entirely concealing the previous whorl: chambers separated by transverse flexuous septa, deeply sinuated towards the edges, divided into branching lobes, and traversed by a continuous tube situated at the outer or dorsal edge of the shell; the last chamber large.

Ammonites are distinguished from other genera of discoidal chambered Cephalopods by the branching lobes of their mantle, causing the edges of the septa to form a very complicated pattern against the side of the whorl, which is seen when the surface is removed or worn away. The forms of these lobes have been used, as distinguishing specific characters, by Von Buch and many subsequent writers. Although I am not disposed to attach so much importance to them as is sometimes done, I have, as far as possible, given an outline of the lobes of the septa of each species.

To facilitate description, Von Buch proposed to restrict the term *lobe* to the more subdivided and branching portions of the edges of the chamber which extend downward from the mouth of the shell, and to call *saddles* the more rounded and less intersected divisions which project upward towards the mouth; thus the outline of a septum is made up of *lobes* alternating with *saddles*. The middle of the back of the whorl is occupied by the *dorsal lobe*, opposite to which is the *ventral lobe*, which, abutting against the previous whorl, is always concealed: between these are the *lateral lobes* and *saddles*. References to these names will be found in the explanation of Plate VII.

In using these characters, the observer must bear in mind that they vary at different ages of the animal, and are therefore practically of less use to the conchologist than might be expected. Not only do all the ramifications of the lobes increase in complexity during the whole life of the Ammonite, a mere notch in the young stage growing into a branch of its lobe, but the number of lobes may also increase with age. According to M. D'Orbigny, all Ammonites have only six lobes at the earliest period of their existence; namely, the dorsal and ventral lobes, and the superior and inferior lateral lobes on each side of the whorl. In some species this number continues the same through life; but more commonly the lobes increase in number with the growth of the shell, small *auxiliary* lobes being added on each side near the junction with the inner whorl. The number of auxiliary lobes varies in different species; but as this depends on the age of the shell, they form a character of little service. Moreover, as the lobes are most branched near the edge of the whorl, many of the minor ramifications are obliterated on the *worn* cast of an Ammonite.

The two sides of the shell being usually symmetrical, it is only necessary to figure the outline of the septa of the back and one side. But there are some species of Ammonites in which the siphuncle, instead of being placed at the middle of the back, is often found more or less on one side; and when this is the case, the lobes of the septa are also displaced to the same extent, so that the tube remains in the middle of the dorsal lobe. Most of those species are symmetrical when young, and the change takes place at very different periods of growth in different individuals. This curious irregularity is most often seen in *A. denarius*, *Fittoni*, *splendens*, and *Lyelli* of the Gault, *A. Duncani* and *Calloviensis* of the Kelloway's Rock. The displacement usually consists in shifting the tube to one of the angles of the back; but specimens of *A. Calloviensis* are found with the tube placed near the middle of one of the sides. M. D'Orbigny has illustrated this deformity in describing, in the Paléontologie Française, the species liable to it.

Many species of Ammonites are distinguished by a large lateral process formed on each side of the mouth, either when the animal is full-grown or at intervals during its growth. Such forms are mostly found in the Oolitic Formations, but *A. rostratus*, which is common in the Upper Green Sand, affords a good example of such a mode of growth.

In many of the secondary strata are found pairs of shelly plates of very peculiar structure, which have received various names, and still more discordant explanations, from different authors. Parkinson called them *Trigonellites*, Von Meyer *Aptychus*, Deslongchamps *Münsteria*. They have been thought by many writers to be external bivalve shells of the Lamellibranchiate order; or internal shells of Cephalalopods; Rüppell thought some of them scales of Reptiles; some have been regarded as palatal teeth of Fishes; and M. D'Orbigny has lately considered them the side plates of pedunculated Cirrhipedes. But the opinion which seems to have most probability in its favour is that the *Trigonellites* were the *opercula* of Ammonites, which view has been ably supported by Voltz;[1] the principal reasons for this opinion are derived from the structure of the plates being analogous to that of many opercula, and their having been often found within the open chamber of Ammonites, to the mouths of which their form and size nearly correspond. Each plate is triangular, with one straight edge, which laps over or under the corresponding edge of its fellow plate. The lines of growth are always seen on the concave side of the plates, showing that to have been the external surface. Voltz divides the Aptychi (or Trigonellites) into three sections: 1st, the *cornei*, consisting of a single (?) horny plate, with a flexible fold down the middle; 2d, the *imbricati*, which have a pair of plates with an external horny epidermis, covered internally, that is on the convex side, with calcareous layers laid over one another like tiles; 3d, the *cellulosi*, which have a pair of plates with a thick, cellular, calcareous layer on the inner or convex surface. The *Trigonellites* are rare in the Chalk; those which have been found will be described in connection with the *Ammonites* to which they are supposed to belong.

In the first volume of the 'Journal of the Geological Society,' p. 232, Mr. Strickland has described some supposed *opercula* of *Ammonites*, consisting of one semi-oval calcareous plate, without any suture, which have been found in the Lias: no similar form has yet been found in the Chalk.

1. Ammonites complanatus, *Mantell.* Plate VII, figs. 1—3.

Ammonites complanatus, *Mantell.* Fossils of the South Downs, p. 118.
— — *Sowerby.* Min. Conch., t. 569, fig. 1.
— largilliertianus, *D'Orbigny.* Paléont. Franç. Terr. Crét., pl. xcv.

A. testâ discoideâ, compressissimâ, læviusculâ, tenuiter striatâ; striis numerosissimis flexuosis, umbilicum versus obsoletis, deinde distinctis et ad margines dorsi sub-tuberculatis;

[1] Neues Jahrbuch, 1837, pp. 304 and 432.

dorso truncato, lateribus subcarinato, medio planiusculo; aperturâ sagittatâ; anfractibus interioribus occultis; umbilico clauso.

Shell discoidal, much compressed, partially smooth, but marked with very numerous striæ, which are only faintly visible on the middle of the whorl, where they curve away from the mouth, and more distinct towards the margin, where they are nearly straight; each of the striæ is produced into a point projecting beyond the edge of the truncated back, thus forming a slight keel on each side of the back; whorls increasing very rapidly in height, and entirely covering the umbilicus; mouth sagittate; lobes of the septa numerous, and much subdivided.

Diameter 8 inches, height of the outer whorl 5 inches, thickness $1\frac{8}{10}$ths of an inch.

Found in the Grey Chalk of Hamsey, near Lewes. The species is very rare; and I have only seen the two specimens figured, which were collected by Dr. Mantell, and are now in the British Museum; M. D'Orbigny states that it is very rare in France, and has been found at Rouen and Cassis, in the beds of the same age as in England.

This species and the next described, *A. obtectus*, are nearly related, and are remarkable for the rapid increase of the height of their whorls, which entirely close the umbilicus; and also for the great flexure of the upper edges of the lobes of the septa, which project forward in the middle of the whorls, in a very unusual degree.

2. Ammonites obtectus, *Sharpe*. Plate VII, fig. 4.

A. testâ discoideâ, compressissimâ; lateribus delicatim costatis: dorso truncato, tricarinato; costis numerosissimis, complanatis, medio angulatis et tuberculatis; carinis dorsalibus nodulosis; aperturâ truncato-sagittatâ; anfractibus interioribus occultis; umbilico clauso.

Shell discoidal, much compressed, with slightly convex sides, and a narrow truncated back; ornamented on the sides with numerous flat ribs, which rising at the umbilicus slope forward in a straight line to the middle of the whorl, whence they bend back at a sudden angle, and continue in a slight curve to the dorsal margin, where they terminate; every second or third rib bears a rounded tubercle at the angle, on the middle of the whorl; and here and there a rib is inserted between the others reaching only from the row of tubercles to the dorsal margin; the angle of flexure of the ribs varies with age, being at first very obtuse, and changing gradually till it becomes about a right angle; back narrow and truncated, with three keels, which are ornamented with small knobs equal in number to the ribs; each lateral keel is marked off from the side of the whorl by an impressed line running very near the edge; whorls increasing very rapidly in height, and entirely covering the umbilicus; section of the whorls sagittate with the point cut off; septa with long, very narrow, and ramified lobes, which are only partially seen in the specimen figured.

Diameter of our only specimen $2\frac{3}{4}$ inches, breadth of the aperture $\frac{3}{4}$ths of an inch, height of the last whorl $1\frac{3}{4}$ths of an inch; but the specimen must have been much larger, as it originally had, at least, one more whorl.

Found by Mr. Wiest at Chardstock, in the Chalk with siliceous grains.

This elegant shell has some characters which are so rare among the Ammonites, that we only know one other species to which to compare it, *A. complanatus*, Sow. (*A. largilliertianus*, D'Orb.); it agrees with that species in general form, in the embracing character of the whorls, covering the umbilicus, and in the curve of the septa, which advance towards the middle of the whorl, and fall back towards the ventral and dorsal margins; from this last character combined with the flexure of the ribs we conjecture that the mouth had a sinus in the middle resembling that in the genera *Nautilus* and *Bellerophon*. The lobes of the septa have been imperfectly seen; they bear a strong analogy to those of *A. complanatus*, without altogether agreeing with them. The description being taken from a single imperfect specimen is necessarily incomplete: this specimen appears to be unique.

3. AMMONITES FALCATUS, *Mantell.* Plate VII, figs. 5—9.

AMMONITES FALCATUS, *Mantell.* Fossils of the South Downs, t. xxi, figs. 6 and 12.
— — *Sowerby.* Min. Conch., t. 579, fig. 1.
— — *D'Orbigny.* Paléont. Franç. Terr. Crét., t. xcix.
— CURVATUS, *Mantell.* Loc. cit., t. xxi, fig. 18.
— — *Sowerby.* Min. Conch., t. 579, fig. 2.

A. testâ discoideâ, compressâ, bicurvato-costatâ, tuberculatâ; tuberculis, costisque numero variantibus; dorso canaliculato, utrinque tuberculato; umbilico mediocri; aperturâ oblongâ.

Shell discoidal, and flattened, with numerous ribs extending from the umbilicus to the edge of the back, in double curves, meeting in advancing angles on the middle of the side, and variously tuberculated; back with tubercles on each side, and a hollow canal in the middle; umbilicus of middling size, bounded by steep sides; whorls half concealed; aperture oblong; septa with two lateral lobes, slightly subdivided.

The above are the most constant characters in this very variable species, in which the ribs are either very broad or minutely sub-divided, or replaced by tubercles. The best marked varieties are those which were described by Mantell and Sowerby as distinct species, although specimens may be found with all the characters of both varieties combined, as fig. 5. *A. falcatus* originally included the forms without lateral tubercles, as our fig. 7, and *A. curvatus* the more tuberculated forms, like fig. 6, which have two rows of tubercles on each side of the back. We are indebted to M. D'Orbigny for uniting them. The tubercles usually diminish in number and prominence, as the shell increases in

growth; but fig. 8 is a very remarkable variety, in which the tubercles have almost taken the place of the ribs, of which only a few are to be seen in a very young stage.

Diameter 2 inches; thickness $\frac{6}{10}$ths of an inch.

Found sparingly in the Grey Chalk, the Chloritic Marl, and the Chalk with siliceous grains, throughout the Southern Counties; and also in the Green Sand of Blackdown. It occurs in beds of the same age in France.

A. falcatus is related to *A. lautus* and *A. tuberculatus*, which have a similar canal down the back; but the peculiarly curved ribs readily distinguish it from those species, while its dorsal canal distinguishes it from several species which have ribs with a similar double curve.

4. Ammonites varians, *Sow.* Plate VIII, figs. 5—10.

Ammonites varians, *Sowerby*. Min. Conch., t. 176, lower figures only.
— — *Brongniart*. Envir. de Paris, t. vi, fig. 5.
— — *Bronn*. Lethæa Geogn., t. xxxiii, fig. 2.
— — *D'Orbigny*. Paléont. Franç. Terr. Crét., t. xcii, figs. 3, 4, & 5.
— — *var.* intermedia and *var.* sub-plana, *Mantell*. Fossils of the South Downs, t. xxi, figs. 2, 5, and 7.
— Brongniartii, *Haan*. Amm. et Goniat., No. 43.

A. testâ discoideâ, radiatâ, tuberculatâ, carinatâ; radiis numerosis flexuosis, plerumque furcatis, bi-vel tri-tuberculatis; tuberculis parvis; dorso carinato, lateribus angulatis, tuberculatis, cariná lævi; umbilico mediocri; aperturâ truncato-sagittatâ.

Shell discoidal, ornamented on the sides with numerous flexuous, simple, or forked ribs, each of which bears a small tubercle at its rise on the edge of the umbilicus, and a larger tubercle at its termination on the side of the back, and in some varieties an additional tubercle at the point of bifurcation; umbilicus rather small and well defined; whorls half concealed; back narrow with a prominent keel, and a row of tubercles at each side; section of the whorls considerably higher than broad, sagittate with a truncated top; aperture with the upper part of the whorl projecting forward, and produced into a blunt point. Septa with 5 or 6 trifid, subdivided lateral lobes.

Ammonites varians, as its name implies, assumes many forms, which may be arranged under the four following varieties:—

1st Var. *sub-tuberculata*, Pl. VIII, figs. 5, 6, and 8. The young shell has about fifteen slight tubercles round the umbilicus, connected by very faint ribs, with about thirty well-marked tubercles at the edge of the back: the adult shell has the ribs more prominent and less numerous, about twelve rising from the umbilicus, and increasing to about twenty at the edge of the back, an additional distinct tubercle occurs at the bifurcation of each rib, and a row of fainter tubercles usually occurs on the branches of the divided ribs, half-way between the fork of the ribs and the back; making four rows of

tubercles on each side of the whorl; the margin of the umbilicus is rounded off; and the width of the aperture varies from seven to eight tenths of its height. This is the commonest form of the species.

2d Var. *costata*, Pl. VIII, fig. 9, of the same form and proportions as the preceding, but with mere undulations of the surface in place of ribs; the tubercles round the edges of the umbilicus and of the back small, but distinct; the other tubercles obsolete. This variety is rare.

3d Var. *intermedia* of Mantell, Pl. VIII, fig. 7; a much flatter shell than the 1st and 2d varieties, the width of the aperture being only half the height of the whorl; the ribs are prominent and more numerous, twenty in number at the umbilicus, increasing to thirty at the dorsal margin; the dorsal tubercles are distinct, the others inconspicuous. Not very abundant.

4th Var. *sub-plana* of Mantell, Pl. VIII, fig. 10; proportions the same as the last, ribs more numerous, but very slight; dorsal tubercles about fifty, small but distinct; no tubercles on the side of the whorl; umbilicus small, well-defined, with the side steep, and bounded by an angular edge with very faint tubercles. Abundant at Ventnor in the Isle of Wight.

The first three varieties usually reach a diameter of two inches to two inches and a half; the fourth variety rarely attains an inch and a half in diameter.

Ammonites varians is found abundantly in the Grey Chalk, the Chloritic Marl, the Chalk with siliceous grains, and the Upper Green Sand, wherever those Formations occur in the southern parts of England. It is common in France in beds of the same age.

The *A. varians* of Sowerby included *A. Coupei*, which is here separated from it, in accordance with the views of Brongniart and many other authors. The reasons for this separation will be found under *A. Coupei*.

The variations in form of the shells still remaining under *A. varians* are so considerable, as almost to justify our regarding the 1st and 2d varieties as one species, the 3d and 4th as another; or, if we admitted M. D'Orbigny's opinion, that the broader shells were females and the flatter ones males, we might take the first two varieties to be the former, and the last two the males: but our present imperfect knowledge of the sexes of living Cephalopods does not justify such a division.

5. Ammonites Coupei, *Brong.* Plate VIII, figs. 1—4. Plate IX, fig. 1.

Ammonites Coupei, *Brongniart.* Envir. de Paris, t. vi, fig. 3.
— — *Haan.* Amm. et Goniat., No. 42.
— — *Bronn.* Lethæa Geogn., t. xxxiii, fig. 4.
— varians, *Sow.* Min. Conch., t. 176, middle and upper figures.
— — var. tuberculata, *Mantell.* Foss. S. Downs, p. 116.
— — *Haan.* Amm. et Goniat., No. 45.
— — *D'Orbigny.* Paléont. Franç. Terr. Crét., t. xcii, figs. 1, 2, and 6.

A. testâ discoideâ, aliquando sub-inflatâ, costatâ, tuberculatâ, carinatâ; costis interruptis, simplicibus vel furcatis, tri-vel quatuor-tuberculatis; tuberculis prominentibus; dorso latiusculo, utrinque tuberculato, medio carinato; umbilico profundo; aperturâ truncato-ovatâ.

Shell discoidal, with the whorls inflated when young, but somewhat flattened when adult, ribbed, and tuberculated; back broad and keeled, with a row of prominent tubercles on each side; aperture ovate, with the upper part of the whorl projecting forward, and produced into a blunt point; umbilicus deep and rounded off at its upper edge. The ribs and tubercles vary much both in size and number at different stages of growth and in different varieties of the species. Septa with four trifid, sub-divided lateral lobes.

This species admits of a division into two strongly-marked varieties, which Haan regarded as distinct species:—

1st Var. *tuberculata* of Mantell, whorls of the young shell (Pl. VIII, fig. 4,) inflated, their width being equal to their height, with three rows of very prominent tubercles connected by thick, ill-defined ribs; the tubercles of the inner row round the edge of the umbilicus are the smallest, ten in number in a very young shell, twelve in a shell of $1\frac{1}{2}$ inch in diameter; the tubercles of the next row, situated on the middle of the whorl, are very large and prominent, and equal in number to the preceding; the tubercles of the outer row on the edge of the back are of an intermediate size, and about half as many again as the others; in the adult shell (Pl. VIII, fig. 2; Pl. IX, fig. 1,) the whorls are a little flattened, the ribs better marked, the tubercles rather less prominent, and a fourth row of small tubercles is inserted between the middle and the dorsal rows; the width of the aperture is equal to $\frac{9}{10}$ths of the height of the whorl. The usual diameter of this variety is about $2\frac{1}{2}$ inches, but specimens are occasionally found in the Grey Chalk of 6 inches diameter: this enlargement is not due to an increased number of whorls, but to a larger size at every stage of growth.

2d Var. *inflata*, Pl. VIII, fig. 1, whorls inflated, their width being one fourth more than their height, with two rows of very large and prominent tubercles; those of the inner row which are seated on the middle of the whorl being the largest, and ten or eleven in number; the outer row on the edge of the back somewhat smaller, and sixteen or seventeen in number; back broad, with a very prominent keel. This variety reached $2\frac{1}{2}$ inches in diameter, and $1\frac{1}{4}$ of an inch in thickness.

Ammonites Coupei is common in the Chloritic Marl of the Isle of Wight, and in the Chalk with siliceous grains of Dorsetshire; and is found sparingly in the Grey Chalk of the Southern Counties.

The original description of *A. varians* in the 'Mineral Conchology' included our *A. Coupei*, which was first separated by Brongniart: most subsequent authors have regarded them as distinct species, until they were reunited by M. D'Orbigny, who considers that all the varieties of the two species pass into one another, and may in part be accounted differences of sex, the more inflated forms being regarded as females. We

know nothing certain respecting the sexual differences of form in Ammonites; but even if it were admitted that such differences existed, they would not suffice to bring *A. varians* and *A. Coupei* together, as in each species there are two well-marked differences of form, so that there are varieties enough to supply distinct sexes in each species. The young shells of both varieties of *A. Coupei* nearly resemble each other; the differences between them begin in their middle stage, and increase as they grow older, the 1st variety gradually approaching *A. varians* in form, while the 2d variety recedes farther from that species. The young *A. varians* always present a strong contrast, in its flat, faintly-ribbed form, to the rounded and tuberculated young shell of *A. Coupei*: it is only in the adult form of one variety of each species that any confusion can arise between them.

6. Ammonites cinctus, *Mantell.* Plate IX, fig. 2.

Ammonites cinctus, *Mantell.* Fossils of the South Downs, p. 116.
— — *Sowerby.* Min. Conch., t. 564, fig. 1.

A. testâ discoideâ; ambulacris rotundatis, transversim costatis; costis tenuibus, alternatim majoribus furcatis ambulacrum totum amplectentibus, minoribus intermediis dorsalibus; dorso rotundato; umbilico parvo; aperturâ ovali.

Shell discoidal, with rounded whorls crossed by numerous slight, irregularly flexuous ribs; these are twelve in number at the umbilicus, divide into two before reaching the middle of the side, and are continued over the rounded back; between each of the branches of the larger ribs there are one or more short ribs, which only extend across the back; umbilicus small; whorls about two thirds concealed; aperture oval. The septa have not been seen.

Diameter, 3·8 inches; width, 1·1 inch.

From the Grey Chalk of Middleham, Sussex. The figure is taken from Dr. Mantell's original specimen, now in the British Museum. No other specimen of the species is known.

A. cinctus is well characterisd by its very peculiar ribbing, and cannot be confounded with any other species. The specimen shows the form of the mouth very nearly complete.

7. Ammonites Bunburianus, *Sharpe.* Plate IX, fig. 3.

A. testâ discoideâ, compressâ, lateribus transversim multi-sulcatâ, dorso tri-seriatim tuberculatâ: umbilico parvo; aperturâ ovato-rhomboideâ.

Shell discoidal with flattened sides; crossed by twenty-five unequal furrows, continued over the back, which is marked by three rows of tubercles; the furrows are very small near the umbilicus, and gradually grow wider and deeper towards the back where they are most important: on the back the spaces between the furrows form broad ribs, each of which has three longitudinally flattened tubercles, one on the middle and one on each side

of the back; umbilicus small, with steep sides; whorls more than half concealed; aperture oval; septa with three slightly indented lateral lobes.

Diameter, $1\frac{1}{4}$ inch; width, $\frac{3}{8}$ths of an inch.

Only one specimen has been seen, which was presented by Mr. E. H. Bunbury to the Museum of Practical Geology; it is from the Chalk with siliceous grains of Chardstock, Somersetshire. The species is named after its discoverer.

8. Ammonites peramplus, *Mantell.* Plate X, figs. 1—3.

Ammonites peramplus, *Mantell.* Fossils of the South Downs, p. 200.
— — *Sowerby.* Min. Conch., t. 357.
— — *D'Orbigny.* Paléont. Franç. Terr. Crét., t. 100, figs. 1, 2.
— Prosperianus, *D'Orbigny.* Loc. cit., t. 100, figs. 3 and 4.

A. testâ subinflatâ: anfractibus rotundatis; junioribus costatis, costis flexuosis, amplectentibus, quarum sex majoribus intus tuberculatis; adolescentibus utrinque undato-costatis, dorso plano; adultis rotundatis, intus sub-undatis; senioribus rotundatis, simplicibus: aperturâ imprimis semi-circulari, deinde ovatâ.

Shell gibbose, with rounded whorls, of which nearly two thirds are concealed, varying in proportions and ornament at different periods of growth; side of the umbilicus very steep; septa with four or five unequally trifid, branching lateral lobes.

The young shell, up to a diameter of two inches, has the whorls broader than they are high, ornamented by about twenty-five rounded ribs, which bend forward as they cross the back; of these six are stronger than the others, and rise from six large pointed tubercles on the edge of the umbilicus, fig. 3, *A. prosperianus*, D'Orb. At a diameter of four to six inches, the intermediate minor ribs disappear, the tubercles become obsolete, and the back smooth, and there remain about twelve broad, rounded, straight ribs on each side of the whorl, which do not meet on the back, fig. 2.

When the shells reaches a diameter of a foot, the whorl is higher than broad, and nearly smooth, with no trace of its previous ornament, except a series of blunt ill-defined tubercles round the umbilicus, connected with faint undulations on the inner half of the whorl (fig. 1).

Very old specimens, which may be found exceeding two feet in diameter, have the whorls smooth and entirely devoid of ornament, and the aperture laterally compressed.

A. peramplus is found in the middle part of the Chalk throughout the counties of Kent, Sussex, Surrey, Hertfordshire, and Wiltshire, and the Isle of Wight; but is most abundant in the South Downs. It reaches from the white chalk without flints high up into the chalk with flints, but large individuals are only found in the lower parts of its range, the uppermost beds in which it occurs only containing very small specimens. M. d'Orbigny quotes it only from the Upper Green Sand of the South of France.

M. d'Orbigny conjectured, p. 335, that his *A. prosperianus* might, perhaps, prove the young of *A. peramplus*, which farther observation has shown to be the case.

PLATE I.

Fig.

1, 2, and 3. BELEMNITELLA MUCRONATA; from the Upper Chalk, near Norwich.

1. Ventral view, with the fissure.

2*a* and *b*. Dorsal and lateral views of a specimen, in which the vascular impressions are well seen.

2*c*. Alveolus from above.

3. Section of another specimen, showing the eccentric position of the alveolus, and traces of the edges of the septa.

4, 5, and 6. BELEMNITELLA LANCEOLATA; from the Upper Chalk, near Norwich.

4*a*, *b*, and *c*. Dorsal, lateral, and ventral views of one specimen.

4*d*. Alveolus from above.

5. Ventral view of a young specimen.

6. Section of another specimen, showing the central alveolus.

7. BELEMNITELLA QUADRATA; from the Middle Chalk of Kent, in the collection of Mr. J. G. Lowe; this specimen is broken at the top.

7*a*. Dorsal view.

7*b*. Side view.

7*c*. Portion of the granulated surface, magnified.

8. BELEMNITELLA QUADRATA; from the Middle Chalk of Kent, in the collection of Mr. Bowerbank.

8*a*. Dorsal view, showing the two lateral depressions.

8*b*. The alveolar opening slightly broken away at the edges.

9. BELEMNITELLA QUADRATA; a young specimen from the Upper Chalk of Northfleet in the collection of Mr. Morris, with the two vascular impressions strongly marked.

9*a*. Dorsal view.

9*b*. Lateral view.

10. BELEMNITELLA QUADRATA; alveolar opening from above, perfectly preserved. In the collection of Mr. Bowerbank.

Fig.

11. Belemnitella quadrata; from the collection of Mr. Bowerbank.

    11*a*. Section, showing the conical form of the lower part of the alveolar opening, and the fissure.

    11*b*. The same, enlarged.

12, 13, 14, 15, and 16. Belemnitella plena; from the Grey Chalk, near Dorking.

    12*a*. Dorsal view.

    12*b*. Upper end, with the lower part of the alveolus preserved.

    13. A young specimen.

    14. Section of a specimen, from which the alveolus is entirely broken off.

    15*a*. Dorsal view of a specimen, broken off at the apex of the alveolus.

    15*b*. Broken end of the last.

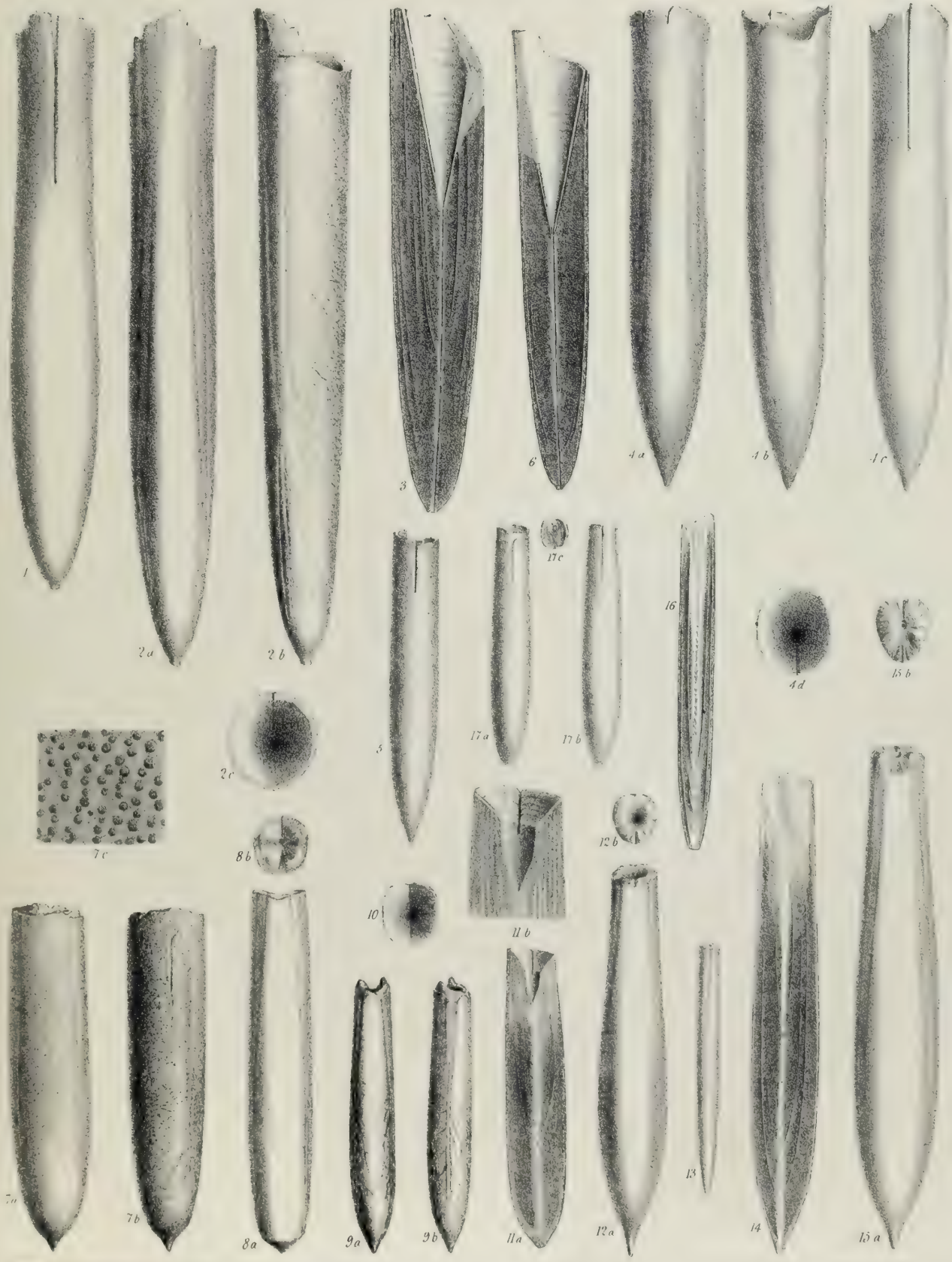
    16. Section of a young specimen.

17. Belemnites ultimus; from the Chloritic Marl of Bonchurch in the Isle of Wight, in the Collection of Mr. Saxby.

    17*a*. Side view.

    17*b*. Ventral view.

    17*c*. Outline of the opening.


1
2a
2b
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6
4a
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17c
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11b
10
7a
7b
8a
9a
9b
11a
12a
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15a

G West, lith

PLATE II.

Fig.

1. NAUTILUS LÆVIGATUS; from the Chalk with siliceous grains of Chardstock, in the collection of Mr. Wiest.

    1*a*. Side view.

    1*b*. Front view.

2. NAUTILUS LÆVIGATUS, young; from the Chloritic Marl of Bonchurch, in the collection of Mr. Saxby.

    2*a*. Side view.

    2*b*. Front view, showing the position of the siphuncle.

3. NAUTILUS EXPANSUS; from the Chalk with siliceous grains of Chardstock, in the collection of Mr. Wiest.

    3*a*. Front view.

    3*b*. Side view.

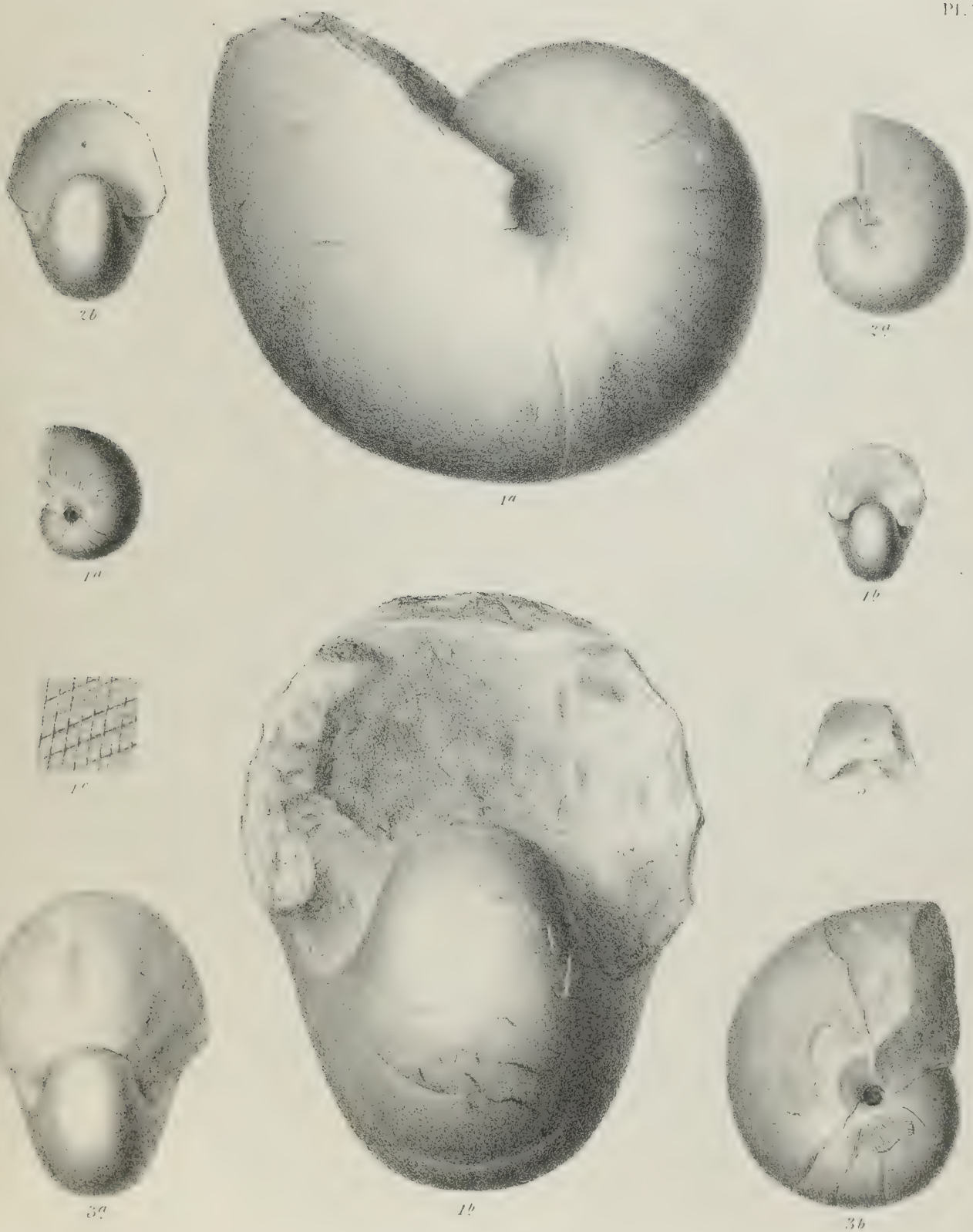
4. NAUTILUS EXPANSUS, young; from the Chalk, with siliceous grains of Chardstock, in the collection of Mr. Weist.

    4*a*. Side view.

    4*b*. Front view.

    4*c*. Portion magnified, showing the cross striation.

5. NAUTILUS EXPANSUS; view of one septum, showing the position of the siphuncle; from Mr. Bunbury's collection.



2b

1a

2a

1a

1b

1c

3

3a

1b

3b

G West, lith

PLATE III.

Fig.

1. NAUTILUS DESLONGCHAMPSIANUS; from the Grey Chalk near Lewes, in the collection of Dr. Mantell.

    1*a*. Side view.

    1*b*. Back view.

2. NAUTILUS DESLONGCHAMPSIANUS; a fragment somewhat crushed, with the cross-ribbing well preserved. From the Grey Chalk, near Lewes.

3. NAUTILUS ELEGANS; from the Grey Chalk near Lewes, in the collection of Mr. Hudson.

    The smooth part of this specimen has been enclosed in another whorl, which is partially broken away.

1b

1a

2

3

PLATE IV.

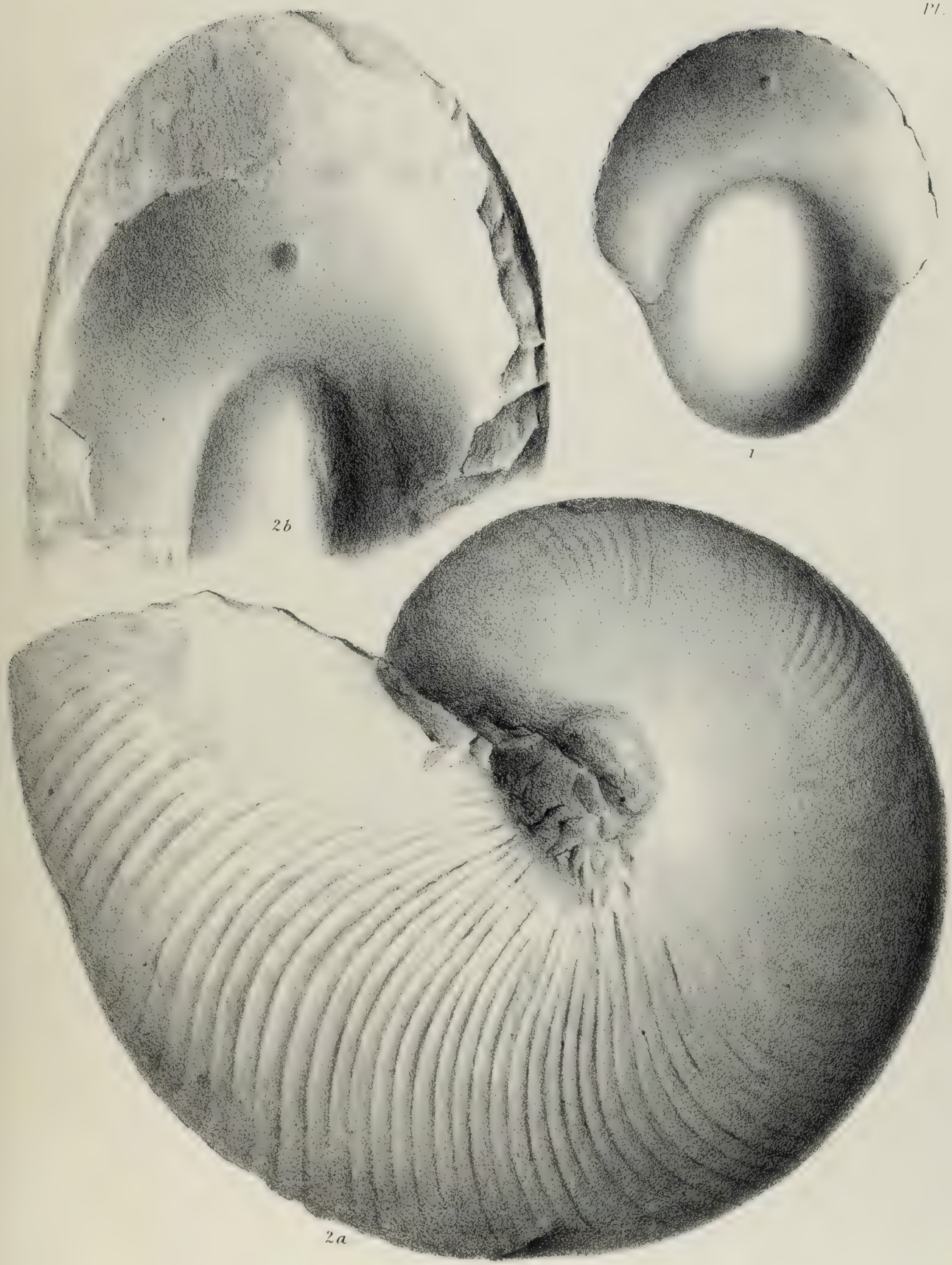
Fig.

1. NAUTILUS ELEGANS, reduced to two thirds; a front view of the inner portion of the specimen figured Plate III, fig. 3, showing the position of the siphuncle.

2. NAUTILUS PSEUDO-ELEGANS; from the Grey Chalk near Lewes, in the collection of the Geological Society.

   2*a*. Side view.

   2*b*. View of one septum, with the opening for the siphuncle.



1

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PLATE V.

Fig.

1. NAUTILUS RADIATUS; from the Chalk with siliceous grains of Chardstock, kindly given me by Mr. Wiest.

    1*a*. Side view.

    1*b*. Front view, showing the position of the siphuncle, and the ventral depression on the septum.

2. NAUTILUS RADIATUS; young specimen, with a portion of the cross-striation of the young shell preserved. From the Chalk with siliceous grains of Chardstock, in the collection of Mr. Morris.

3. NAUTILUS NEOCOMIENSIS; from the Grey Chalk of Urchfont near Devizes, in the collection of Mr. Cunnington.

    3*a*. Side view.

    3*b*. Back view.

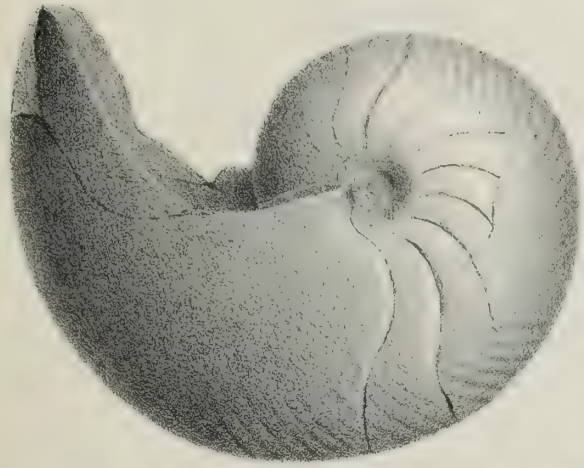
    3*c*. Septum showing the position of the siphuncle.

4. NAUTILUS UNDULATUS; from the Chalk with siliceous grains of Chardstock, in the collection of Mr. Wiest.

    4*a*. Side view.

    4*b*. Front view.

    4*c*. Septum showing the position of the siphuncle.



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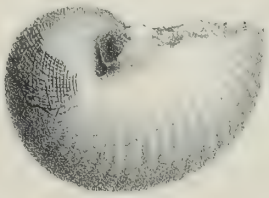
1b



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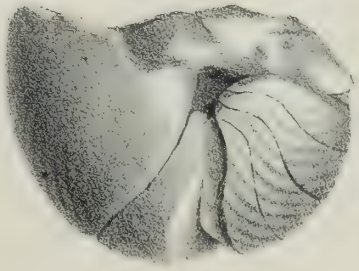
3b



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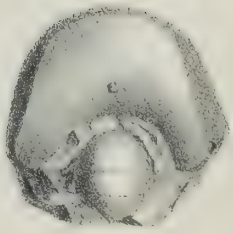

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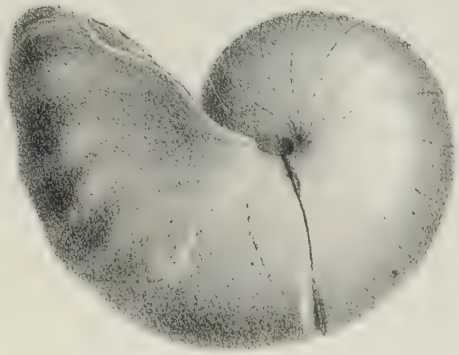


4a

4c

G West lith

PLATE VI.

Fig.

1. NAUTILUS LARGILLIERTIANUS; from the Chalk with siliceous grains of Chardstock, in the collection of Mr. Wiest.

    1*a*. Side view.

    1*b*. Front view.

2. NAUTILUS LARGILLIERTIANUS; a fragment from the Chalk with siliceous grains of Chaldon, in the collection of Mr. Morris.

    2*a*. Side view, with a commencement of undulation on the back.

    2*b*. Septum, showing the position of the siphuncle.

3. NAUTILUS FLEURIAUSIANUS; from the Chalk with siliceous grains of Chardstock, in the collection of Mr. Wiest.

    3*a*. Side view.

    3*b*. Front view.

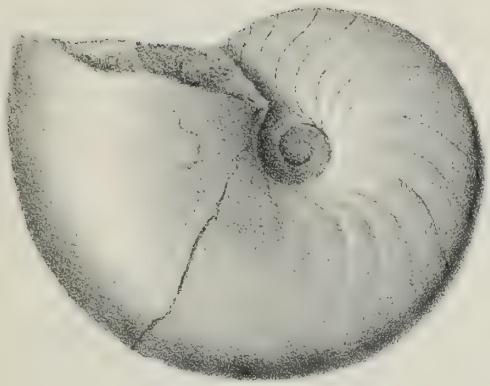
4. NAUTILUS FITTONI; from the Chalk with siliceous grains of Chardstock, in the collection of Mr. Wiest.

    4*a*. Side view.

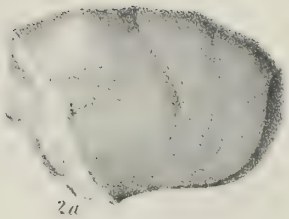
    4*b*. Back view.

    4*c*. Septum showing the position of the siphuncle.

1b.



1a



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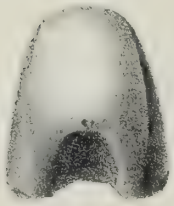
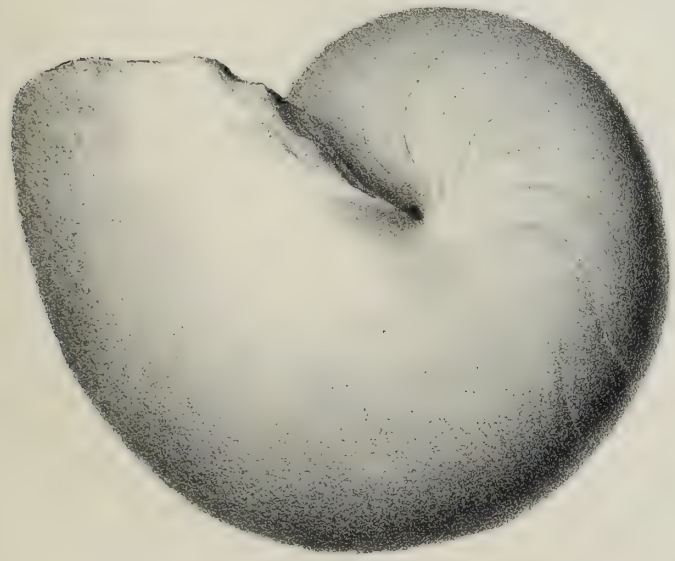


2b



3a

3b

4a

4b

4c

PLATE VII.

Fig.

1—3. Ammonites complanatus.

1. From the Grey Chalk of Hamsey; in the British Museum, from the collection of Dr. Mantell; the original specimen figured, t. 569, of the 'Mineral Conchology,' reduced to half its diameter.

1*a*. Side view.

1*b*. Front view.

2. A young specimen of the natural size; in the British Museum, from the collection of Dr. Mantell.

3. Outline of the margin of a septum, copied from pl. xcv of the 'Paléont. Française Terrains Crétacées.'

d l. The dorsal lobe.

s l l. The superior lateral lobe.

i l l. The inferior lateral lobe.

a a a. Auxiliary lobes.

s d. The dorsal saddle.

l s. The lateral saddle.

t. The position of the siphuncle on the middle of the back.

4. Ammonites obtectus; from the Chalk with siliceous grains of Chardstock, in the collection of Mr. Wiest.

4*a*. Side view.

4*b*. Front view.

4*c*. Portion of the outline of a septum, only extending to the lateral saddle.

5—9. Ammonites falcatus.

5. From the Grey Chalk of the Clayton Tunnel, on the Brighton Railway, in the collection of Mr. Catt.

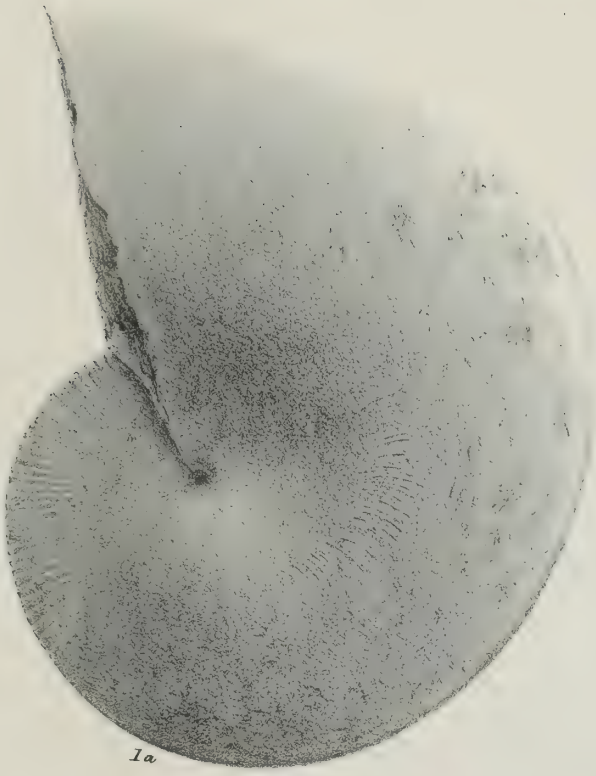
6*a* and *b*. From the Chloritic Marl of Gore Cliff, Isle of Wight, in the collection of Mr. Saxby.

7*a* and *b*. A specimen in the collection of Mr. Morris, from the Chalk with siliceous grains of Chaldon.

8*a* and *b*. From the Chloritic Marl of Bonchurch, Isle of Wight; in the collection of Mr. Saxby.

9. Outline of a septum of a young specimen.

1b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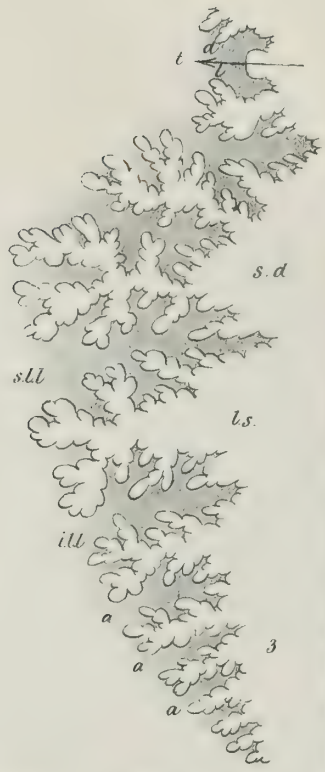
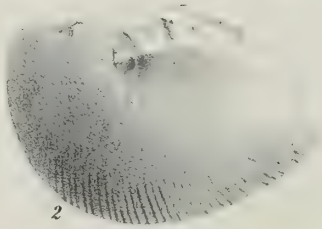



2

4a

4b

5

6a

6b

7a

7b

8b

9

8a

G Wrse lith

Day & Son, Lith.rs to the Queen

PLATE VIII.

Fig.

1—4. AMMONITES COUPEI.

1*a* and *b*. Tuberculated variety; from the Chloritic Marl of Bonchurch, Isle of Wight, in the collection of Mr. Saxby.

2*a* and *b*. Commonest of the species; from the Chalk with siliceous grains of Chardstock, in the collection of Mr. Wiest.

2*c*. Outline of the septum of a young specimen of the tuberculated variety.

3. Outline of the septum of the specimen, fig. 2*a*.

4. Tuberculated variety, young; from the Chalk with siliceous grains of Chardstock, in the collection of Mr. Morris. The lateral tubercles have been partially rubbed off.

5—10. AMMONITES VARIANS.

5*a*, *b*, and *c*. Common form of the species; from the Chalk with siliceous grains of Chardstock, in the collection of Mr. Morris.

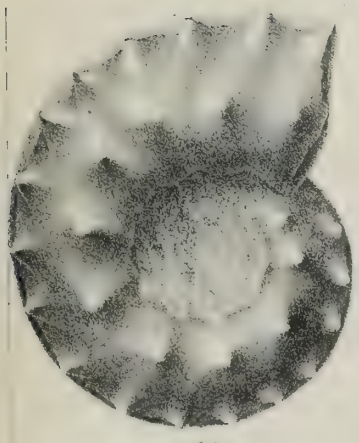
6*a* and *b*. Broken specimen of the same variety as fig. 5, showing the form of the shell when young; from the Chalk with siliceous grains of Chaldon, in the collection of Mr. Morris.

7*a* and *b*. Ribbed variety with obsolete lateral tubercles; from the Chalk with siliceous grains of Chardstock, in the collection of Mr. Morris.

8*a* and *b*. Another variety; from the Chalk with siliceous grains near Lyme Regis.

9*a* and *b*. Smooth variety; from the Chalk with siliceous grains of Chardstock, in the collection of Mr. Wiest.

10*a*, *b*, and *c*. Young specimen of a smooth variety; from the Chloritic Marl of Bonchurch, Isle of Wight.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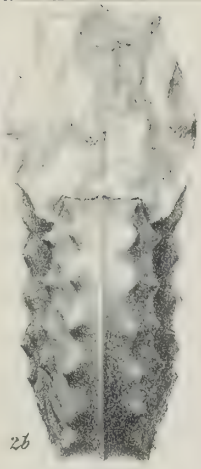
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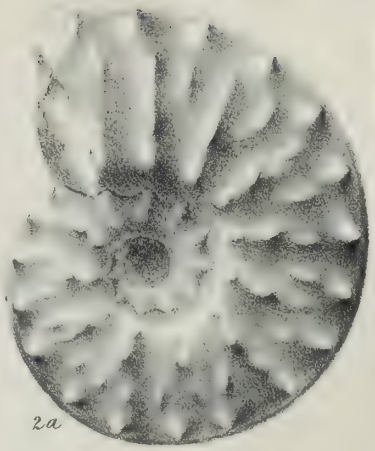
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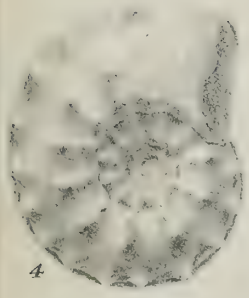
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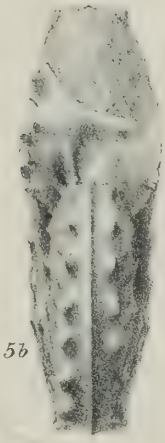
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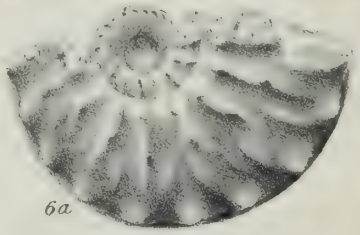
5a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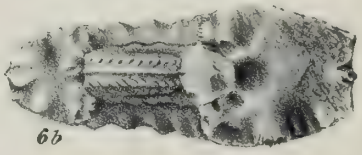
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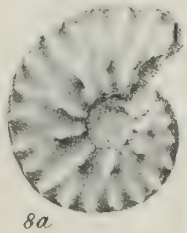
7b

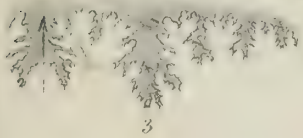
7a

8b


8a

9a

9b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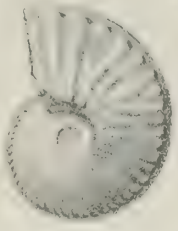
10c


10a

10b

2c

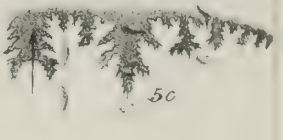

5c

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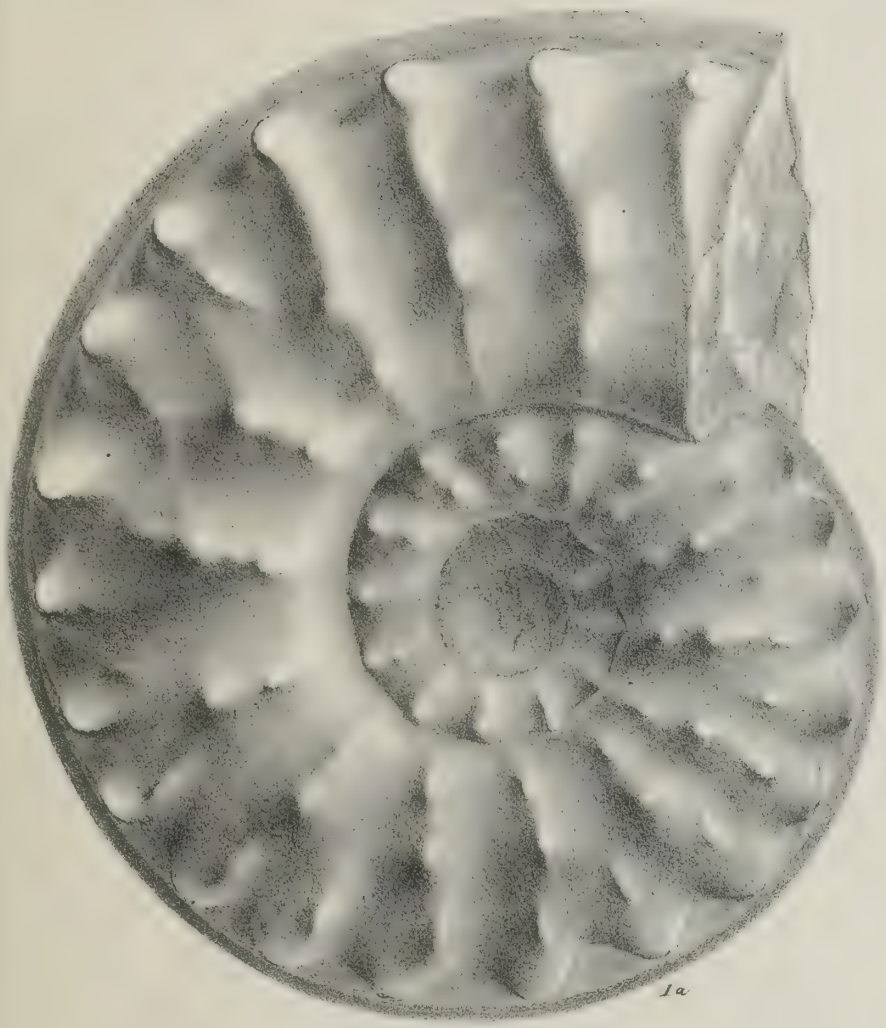
PLATE IX.

Fig.

1*a* and *b*. AMMONITES COUPEI; from the Grey Chalk near Devizes, in the collection of Mr. Cunnington.

2*a* and *b*. AMMONITES CINCTUS; from the Grey Chalk of Middleham, in the British Museum, from the collection of Dr. Mantell: the original specimen described by Dr. Mantell, and figured in the 'Mineral Conchology,' pl. 564.

3*a*, *b*, and *c*. AMMONITES BUNBURIANUS; from the Chalk with siliceous grains of Chardstock, in the Museum of Practical Geology, from the collection of Mr. Bunbury.



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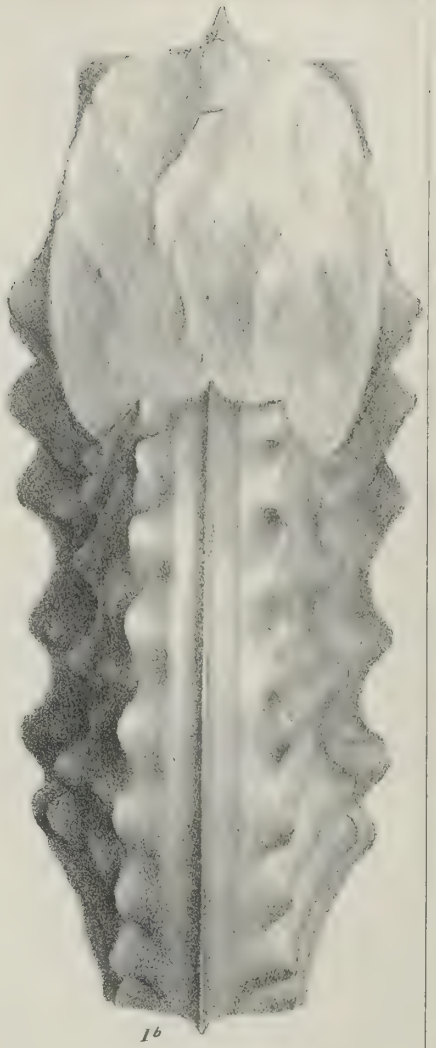
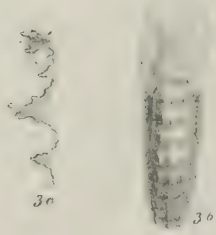


1b

2a

2b



3c 3b

3a

G West, lith

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PLATE X.

Fig.

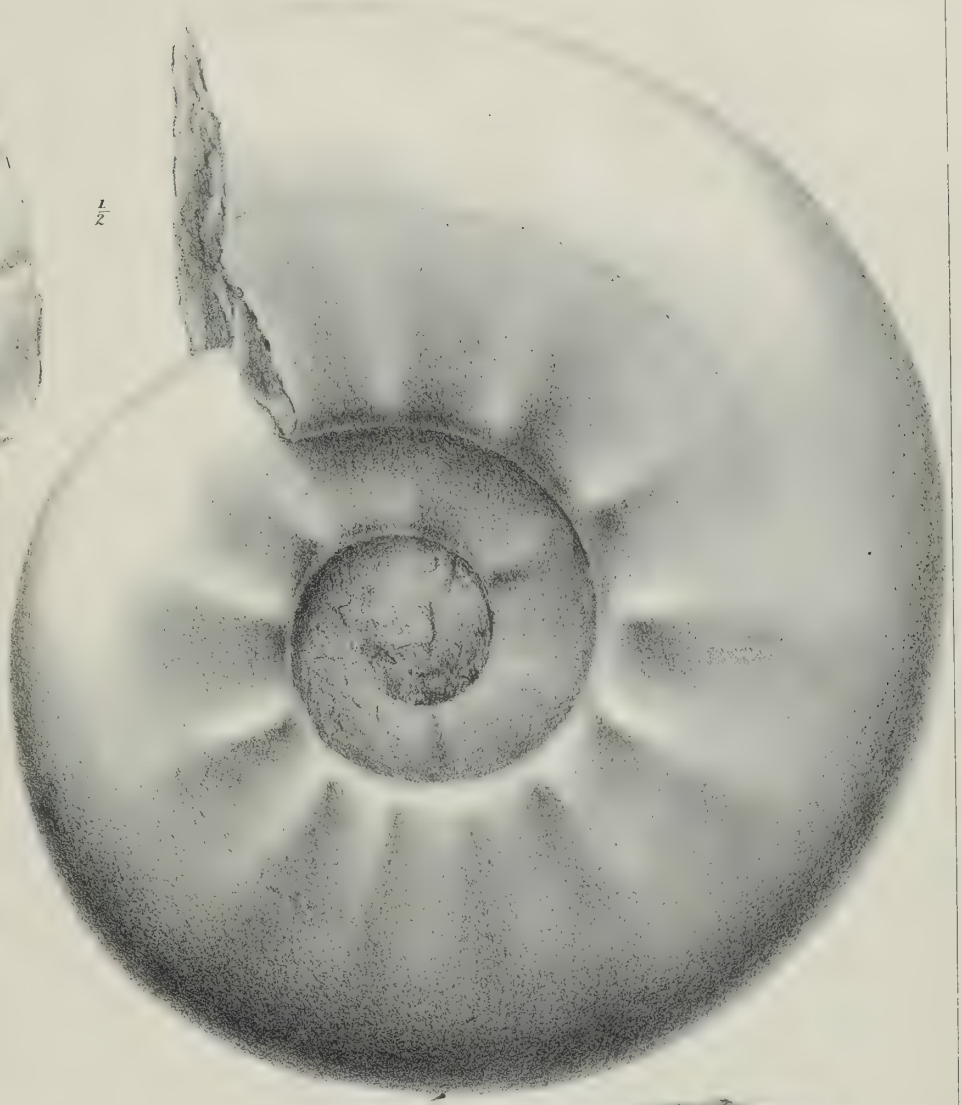
1—3. AMMONITES PERAMPLUS.

1*a* and *b*. An old specimen, figure reduced to one half its diameter; from the Middle Chalk of Wiltshire, in the collection of Mr. Cunnington.

2. Specimen of intermediate age, of the natural size; from the Middle Chalk of Hemel Hampstead, in the collection of the Geological Society: with the outline of one of its septa.

3*a* and *b*. Young specimen of the natural size; from the Middle Chalk of Wiltshire, in the collection of Mr. Cunnington.

1b



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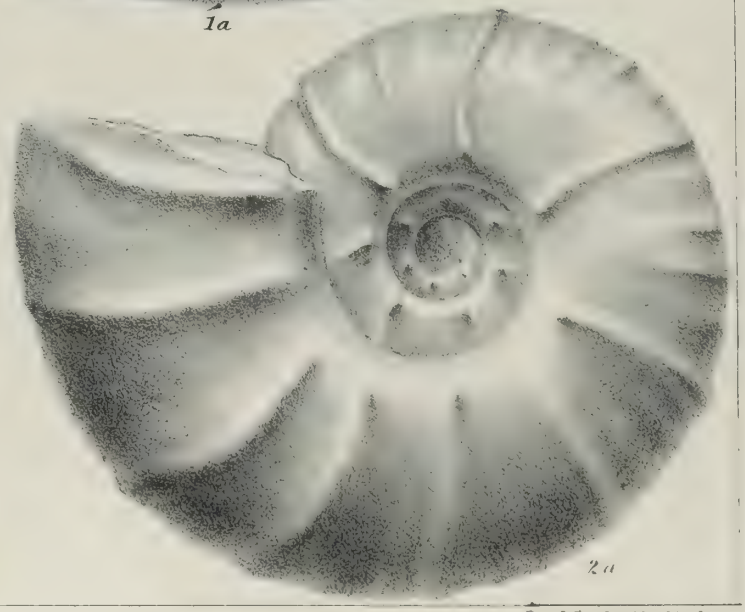
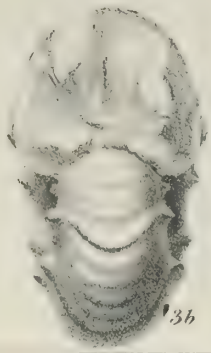


2a

3a



3b

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Day & Son Lith.rs to The Quee

THE

PALÆONTOGRAPHICAL SOCIETY.

INSTITUTED MDCCCXLVII.

LONDON:

MDCCCLIII.

A MONOGRAPH

OF THE

MOLLUSCA FROM THE GREAT OOLITE,

CHIEFLY FROM

MINCHINHAMPTON

AND

THE COAST OF YORKSHIRE.

BY

J. MORRIS, F.G.S. AND JOHN LYCETT.

PART II.

BIVALVES.

LONDON:

PRINTED FOR THE PALÆONTOGRAPHICAL SOCIETY.

1853.

C. AND J. ADLARD, PRINTERS, BARTHOLOMEW CLOSE.

A MONOGRAPH

OF THE

MOLLUSCA FROM THE GREAT OOLITE.

PART II.

BIVALVES.

Upon a general review of the Oolitic Lamellibranchiate Mollusks, it will be found that a very large proportion consists of shells whose hinges may be arranged under one or other of the following two groups, each of which has various generic modifications. The first consists of a lengthened hinge plate, having a parallel series of transverse or oblique teeth, as exemplified by *Arca*, with its sub-genera *Cucullæa*, *Nucula*, *Leda*, *Macrodon*, *Isoarca*, *Limopsis*. The second kind of hinge is altogether destitute of teeth, and comprises the several genera of fossil *Myadæ*, as *Pholadomya*, &c., *Mytilus* with *Modiola*, *Lithodomus*, *Pinna*, *Trichites*, and *Thracia*. Deducting these, together with the forms whose hinge possesses only a ligamentary fossa, as *Lima*, *Pecten*, *Hinnites*, *Plicatula*, and those in which the ligament is inserted in distinct pits, as *Gervillia*, *Perna*, &c., it will be found that shells with hinge teeth constitute only a minority, and that the great family of the *Veneridæ*, though numerous with respect to individuals and number of species, pertains only to few genera. Experience has led us to distrust many generic names which have been given to these fossils, as *Pullastra*, *Donax*, *Tellina*, *Amphidesma*, *Chama*, *Lutraria*, *Sanguinolaria*, *Mactra*, *Gastrochæna*, and *Spondylus*; *Panopea* is also a genus to which a very heterogeneous assemblage of testacea has been referred; *Plagiostoma* has by common consent fallen from the list of genera, the Oolitic species being now referred to *Lima*. Nor has it in any one instance been ascertained that any of the Oolitic bivalves have spoon-shaped processes corresponding to those of the recent *Mya* and *Lutraria*. The shelly beds of the Great Oolite appear to have been accumulated in a sea not sufficiently tranquil to become the habitat of the *Myadæ*; the entire family were gregareous, but in the shelly Oolite we rarely discover a single valve of *Arcomya*, *Ceromya*, or of *Homomya*, the other genera of *Myadæ* being absent altogether. The crypts of *Lithodomus* prove that genus to have existed in great profusion, although it is very rare that the shells are found in the perforations themselves, neither can they be

detected in the substance of the valves of *Trichites*, although few shells of that genus, or of the adult specimens of *Crassina*, can be found, which are not bored or even honeycombed by their perforations, a fact which should teach us that the numbers of fossil specimens do not afford in every instance a sure indication of their former actual numbers. The *Trigoniæ*, which hold so important a position in the Oolitic testacea, are represented in the shelly beds by a great profusion of individuals; nevertheless, these beds do not appear to have possessed conditions favorable to the development of the several species; three occur abundantly in their earliest stage of growth, but in proportion as they increase in size, their numbers diminish, so that adult specimens are comparatively rare. In the species referred to *Pteroperna* (a sub-genus of *Avicula*), will be found some interesting forms serving to connect *Avicula* and *Pterinea* with the *Polyodontæ*, the hinge being somewhat identical with that of *Macrodon;* it occupies a conspicuous position in the Oolitic system. Another new generic form which remains to be exemplified is *Tancredia*, (*Hettangia*, Terquem;) although of small dimensions, and destitute of ornament or remarkable figure, it is nevertheless the genus which, by the constantly recurring force of numbers, most strongly dwells upon the recollection of those who have with their own hands cleaved the shelly beds of the Great Oolite.

On the other hand, in the muddy deposits which are associated with the Great Oolite, the family of *Myadæ* were tolerably abundant, if we may judge from the numerous species of *Pholadomya*, *Panopæa*, and its allied genera, *Pleuromya*, *Arcomya*, *Homomya*, which are found in the beds of indurated marl, intercalated with or overlying some portions of the shelly Oolite, throughout an extensive area; whilst many of the shells, the *Pholadomya* especially, retain the normal position in which they appear to have lived.

Bivalvia, *Linn.*—Lamellibranchiata, *Blainv.*

Ostrea, *Linnæus*, 1758.

General Character. Shell adherent, inequivalve, foliaceous, irregular; umbones separated, slightly diverging; ligament internal, placed in a deep grooved trigonal pit, beneath the umbones. Muscular impression nearly central.

Ostrea rugosa, *Goldf.* Tab. I, fig. 4.

Ostrea rugosa, *Goldf.* Petref., tab. 72, fig. 10.

Testâ ovatâ, valvâ inferiore profundâ concentricè rugosâ, margine inferiore plicato; superiore subconvexâ, undulatâ-rugosâ.

Shell ovate; inferior valve deep, with concentric rugose plications, the lower margin plicated; the upper valve slightly convex, rugose, and undulated.

The typical form of this shell, which we have provisionally referred to *O. rugosa*, Goldf., has a considerable resemblance to *O. acuminata;* but the attached surface is

usually much larger, and the entire form is more irregular; it may be regarded as forming a passage between the crescentric figure of that shell and the less oblique species, with radiately plicated surfaces and margins; it was eminently gregareous, and most abundant upon the flaggy beds or tile stones of the Forest Marble; in the shelly beds of the Great Oolite it is much less common, and the specimens are usually small.

Localities. The vicinity of Tetbury and Cirencester in the Forest Marble; Minchinhampton Common in the Great Oolite.

OSTREA ACUMINATA, *Sow.* Tab. I, fig. 1, 1*a*.

OSTREA ACUMINATA, *Sow.* Min. Conch., t. 135, f. 2 not 3, 1816.
— — *Roemer.* Verst. Oolith., ii, p. 25, t. 18, f. 16.
— — *Bronn.* Leth. Geog., p. 192.

Testâ ovato-elongatâ, interdum subcrescenticâ; valvâ inferiore convexa, umbone obliquo, acuminato; valvâ superiore subplanâ, ovatâ, tenui.

Shell ovately elongated, frequently subcrescentric, with concentric plications; umbones oblique, acuminated; the smaller valve flattened, thin, ovate.

This little species exhibits a full share of the varieties of form proper to the genus; in the marls and subordinate beds of hard rag in the Fuller's-earth, the valves constitute a considerable portion of the entire deposit, and in the shelly beds of the Great Oolite it occurs in great profusion; in France and the Jura it occupies a similar position, and in equal prominence.

Localities. Bath, Minchinhampton, and numerous other localities throughout the course of the Fuller's-earth and Great Oolite.

OSTREA COSTATA, *Sow.* Tab. I, fig. 5, 5*a*.

OSTREA COSTATA, *Sow.* Min. Conch., t. 488, f. 3, 1825.
— — *Goldf.* Petref, t. 72, f. 8.
— — *Bronn.* Leth. Geog., p. 190, t. 18, f. 18, 1851.
— — *Deshayes.* Traité Element., t. 53, f. 10—12, 1850.
KNORRII, (*Voltz.*) Zieten Wurtt., lx, t. 45, f. 2.

Testâ parvulâ, obliquâ, ovali, valvâ inferiore profundâ costatâ; umbone affixo, costis dichotomis radiatâ; superiore planâ subradiatâ.

Shell small orbicular, or obliquely oval, the attached valve deep with numerous branched and somewhat rounded ribs, upper valve flat, margin undulated.

Mr. Sowerby remarks that the "branching, rounded ribs upon the under surface define this neat little oyster." It is one of the miniature productions of the Ancliff Limestone.

Localities. In the Cornbrash and Forest Marble of Wiltshire and Somerset; and in the Great Oolite of Ancliff, Wiltshire, and in Gloucestershire.

OSTREA GREGAREA, *Sow.*, var. Tab. I, fig. 2, 2*a*.

OSTREA GREGAREA, *Sow.* Min. Con., t. 111, f. 1 and 3, 1815.
— — *Goldf.* Petref., t. 74, f. 2.
— — *Bronn.* Leth. Geog., p. 188, t. 18, f. 16, 1851.
— PALMETTA, *Sow.* Min. Con., t. 111, f. 2?

Testâ crassâ, ellipticâ, incurvatâ costatâ, valvâ inferiore sub-carinatâ, affixâ, superiore convexo-planâ, costis numerosis, rugosis, subacutis radiantibus vel distichis.

Shell oblong, irregular, curved, costated, with unequal convex valves, the beaks slightly produced and incurved; costæ numerous, rugose, diverging.

The specimens figured, are referred to the *O. gregarea*, Sow., a social species which occurs abundantly in the Coralline Oolite of Westbrook, Wiltshire, and near Weymouth in Dorsetshire. The shells referred to this species in the Great Oolite are not generally in good condition, and vary in form and plaiting; some specimens presenting the characters of *O. solitaria*, Sow., others resembling the young state of *O. flabelloides*, Lamarck.

Localities. Minchinhampton, and in the Oolite of Lincolnshire; Stonesfield, Oxfordshire.

OSTREA SUBRUGULOSA. Tab. I, fig. 6, 6*a*.

? Var. of OSTREA ACUMINATA, *Sow.*

Testâ subtrigonâ, incurvâ, concentricè rugosâ; valvâ inferiore convexâ, sulcis furcatis irregulariter radiantibus ornatâ; valvâ superiore sub-planâ; apicè obliquo sub-acuto.

A somewhat trigonal incurved shell, concentrically imbricated or rugose, and with irregular diverging small furrows on the convex valve; the umbone incurved and obtuse; smaller valve flat and nearly smooth.

A very common and characteristic species of the upper portions of the Great Oolite in Northamptonshire and Lincolnshire, where it occurs in sandy and clayey beds, which may probably represent the Forest Marble. It bears a general resemblance to the *O. acuminata*, Sow., of which it may prove to be only a variety from difference of habitat, but is distinguished by the more convex form and furrowed surface of the larger valve.

Localities. In the Oolite of Kingsthorpe, Thrapston, Oundle, &c., Northamptonshire; and near Stamford, Lincolnshire.

OSTREA SOWERBYI. Tab. I, fig. 3, 3*a*.

OSTREA ACUMINATA, *Sow.* Min. Con., t. 135, f. 3 not 2.

Testâ depressâ, elongatâ, curvatâ rugosâ, concentricè lamellosâ; valvâ inferiore sub-convexâ, superiore planâ; umbone obtuso.

A depressed elongated and slightly-curved shell, marked by concentric lamellæ at distant intervals. The umbones are nearly equal in size, broad, and obtuse. The larger valve is rather convex; the smaller valve flat, or sometimes a little concave.

This species is considered to be distinct from the *O. acuminata*, which is more regular, symmetrical, and incurved. It is very abundant in certain marly deposits belonging to the upper portion of the Great Oolite in Northamptonshire.

Localities. Sharnbrook and near Bedford; Blisworth, Kingsthorpe, Yardley and Aynhoe, Northamptonshire; Sapperton, Gloucestershire.

Sub-Genus—EXOGYRA.

Shell with the umbones involute.

EXOGYRA AURIFORMIS, *Goldfuss.* Tab. I, fig. 7.

EXOGYRA AURIFORMIS, *Goldfuss.* Petref., t. 86, f. 5.
— — *Buckman.* In Geol. of Cheltenham, p. 69.
? OSTREA OBSCURA. *Sow.* Min. Con., t. 488, f. 2?

Testâ ovato-suborbiculari depressâ, valvâ minore planâ, inferiore subconica; umbonibus minutis involutis; laminis concentricis tenuissimis irregularibus.

Shell ovately-orbicular, depressed, the smaller valve flattened, the larger subconical with a large adhering surface; umbones very small and involute; laminæ of growth concentrical, very delicate, and irregular.

This pretty species is sufficiently distinct from the contemporaneous species; it was collected by Professor J. Buckman, in a bed of yellow clay at Sevenhampton Common, and he has kindly placed it at our disposal.

Locality. Sevenhampton Common near Cheltenham.

PLACUNOPSIS. *Nov. Gen.*

Testâ suborbiculari, inæquivalvis, irregulari, tenui, non-auriculatâ; valvâ majore convexâ, subobliquâ, umbone depresso, submarginali; lineis radiantibus undulatis ornatâ; margine cardinali brevi subrecto. Valvâ minore planâ integrâ, interdum affixâ. Cardo dentibus nullis, foveâ parvâ transversâ internâ. Impressio musculari magno (biloba)? elliptica, subcentrali.

Shell suborbicular, inequivalve, irregular, very thin, without ears; the larger valve convex, rather oblique, its umbo depressed and submarginal, the surface ornamented with undulated radiating lines; hinge-margin short, nearly straight. The smaller valve is flat, destitute of any foramen, and not unfrequently is affixed by its surface to other bodies. Hinge without teeth, with a small mesial transverse internal groove to contain the ligament. Muscular impression large (bilobed?), elliptical, subcentral.

This genus in its figure and character of the surface presents a considerable resemblance, both to *Anomia* and *Placuna*, but although possessing certain features of affinity to each of these forms, it is not the less separated from them by other characters of some importance. It is so irregular, that scarcely two specimens have exactly the same figure, so that the longer diameter may be either lateral or otherwise; notwithstanding this irregularity, however, it will be observed that the posterior or left side of the convex valve

is more produced, and has more convexity than the other; the substance of the test is papyraceous, and the surface of the convex valve often displays markings, which prove that for a considerable period these shells were attached to other bivalves by the surface of the flat valve, but that valve has never actually been observed attached, and it is very commonly preserved with the outer surface destitute of any traces of having been adherent. Judging therefore from the varying dimensions of the specimens, it does not appear that it adhered at any particular stage of its growth, but that it was only occasionally attached. From *Placuna* it is distinguished by the absence of internal diverging teeth; it is never auriculated, as in *Posidonia*, and the position of the hinge groove is very different; in *Posidonia* it forms a depression in the hinge plate, lengthened laterally, but in our genus it is transverse. The form occurs throughout the Oolitic rocks of England, exemplified by several species, which have usually been referred either to *Anomia* or to *Placuna*,—an erosion which not unfrequently occurs at the thinnest part of the valves where the muscular impression is situated, having apparently been mistaken for the foramen of an *Anomia*.

PLACUNOPSIS JURENSIS, *Roem.* Sp. Tab. I, fig. 8, 8*a b*.

PLACUNA JURENSIS, *Roemer*. Verst. Nord. Deutsch. Ool., p. 16, t. 16, f. 4.
ANOMIA JURENSIS, *Morris*. Cat. Brit. Fos., p. 105, 1843.

Testâ orbicularis, irregulari, papyraceâ, sublamellosâ; valvâ convexâ, umbone obtuso, depresso, submarginali; lineis radiantibus nodosis, laminis concentricis impressis. Valvâ alterâ planatâ, umbone parvo depresso, lineis radiantibus undatis et tenuissimis.

Shell orbicular, irregular, very delicate, somewhat lamellose; convex valve with the umbo, submarginal, obtuse, and depressed; radiating lines knotted, fine, numerous, waved and irregularly impressed with the concentric laminæ. The other valve flattened or irregularly concave, its umbo small and depressed, the surface ornamented with numerous irregular radiating knotted lines.

In numerous instances this species attached itself by the flat valve to *Pectens*, *Limæ*, and *Trigoniæ*, whose characteristic markings although scarcely, if ever, indicated on the interior of either valve, appear distinctly impressed upon the outer surface of the convex valve, almost obliterating the ornamented structure proper to the valve, so that the surface of the *Placunopsis* seems like a delicate tissue or veil spread over the *Trigonia* or *Pecten*. What renders this fact the more remarkable is, that the species of *Lima*, *Pecten*, and *Trigonia*, are very abundant, and are invariably found free from other attached shells. The valves of this delicate shell are abundant in the shelly beds of the Great Oolite, and occur likewise, though more rarely, in the Fuller's-earth and Inferior Oolite of Gloucestershire; but care is required to detach specimens, as it breaks with any trifling concussion.

Localities. Minchinhampton Common and Bisley Common in the Great Oolite.
Leckhampton Hill and Nailsworth in the Inferior Oolite.

PLACUNOPSIS SOCIALIS. Tab. I, fig. 9, 9*a*.

Testâ parvâ ovato-orbiculari, valvis valde inæqualibus et irregularibus, lineis radiantibus subtillissimis confertis; plicis concentricis paucis irregularibus.

Shell small, ovately orbicular, with the valves very unequal and irregular; the umbones are marginal but very depressed, and scarcely distinguishable; the surface is covered with extremely fine densely arranged radiating lines, which are commonly visible under a magnifier upon the convex valve, and very rarely in the flat valve; the concentric plications are few, strongly marked and irregular.

This little shell is usually coloured with tints varying from lake to indigo and brown; it occurs throughout all the shelly beds of the Great Oolite in the Minchinhampton district; and towards the middle of the series in the soft shelly Oolite or oven stone, it is peculiarly abundant and gregareous, the largest specimens having a diameter of about 7 lines; although it does not exhibit any marks of having been attached or compressed, the figure of the valves is even more irregular than in *P. Jurensis*.

Localities. Minchinhampton and Bisley Commons.

PLACUNOPSIS ORNATUS. Tab. I, fig. 11, 11*a*.

Testâ parvâ, ovato-orbiculari subplanâ, fragili, umbonibus sub-marginalibus depressis, costulis radiantibus numerosis equalibus et regularibus, aliisque interstitialibus tenuissimis, costulis spinis fistulosis, numerosis, depressis ornatis.

Shell small, ovately orbicular, transverse, compressed, irregular, very thin; umbones sub-marginal, depressed, radiating costæ elevated, rounded, numerous, equal and regular, with interstitial and very fine striæ; the costæ are ornamented with numerous depressed fistulous spines.

The radiating costæ are elevated and undulated, and the numerous depressed fistulous spines which ornament them render it a pretty object under the magnifier; the character of the surface altogether is very similar to that of *Ostrea spondyloides*, (Schloth, Goldfuss, t. 72, fig. 5,) but that species pertains to the *Muschelkalk*. The other valve has not been recognised.

Locality. Minchinhampton Common.

PLACUNOPSIS RADIANS. Tab. I, fig. 10.

Testâ parvâ sub-orbiculatâ, umbone parvâ, depresso, sub-marginali, lineâ cardinis subrectâ; costulis radiantibus rotundis distantibus et fistulosis, interstitialibus lævigatis; plicis concentricis distantibus.

Shell small, sub-orbicular; umbo small, depressed, sub-marginal, hinge line nearly straight; radiating costæ rounded, elevated, rather irregular, distant, with fistulous plications upon their surfaces; the interstitial spaces are smooth; the concentric plications are few and distant; the general convexity of the shell is moderate, but the convex valve is unknown: not unfrequently near to the border a second series of costæ commence, but

which have no particular reference to the size of the shell. The large distant radiating costæ will distinguish this from *P. ornatus*, to which it is nearly allied.

Locality. Minchinhampton Common, where it occurs rarely in the soft shelly Oolite beneath the planking.

Pecten, *Lamarck.*

Pecten, *Rumphius, Chemn., Bolten, &c.*
Janira, *Schum, D'Orb.*
Neithea, *Drouet.*

Gen. Char. Shell regular, inequivalve, inequilateral, eared, hinge margin straight, surface with radiating ribs, lines or other elevations: hinge destitute of teeth, but having a central triangular pit containing the cartilage, muscular impressions one in each valve, large, sub-central.

Pecten vagans, *Sow.* Tab. I, fig. 12, 12*a*.

Pecten vagans, *Sow.* Min. Con., t. 543, figs. 3, 4, 5, 1826.
— sulcatus, *Young* and *Bird.* Geol. Yorks. 333, t. 9, f. 9.

Testâ ovatâ sub-compressâ, sub-æquivalvi, lamellis imbricatâ, costis raris regularibus (10—11), *valvæ sinistræ angustis, squamis squamosis magnis, regularibus; dextræ costis latis confertim lamello-imbricatis; auriculis magnis inæqualibus lineatis.*

Shell ovate, rather flattened, nearly equivalve, with imbricated lamellæ; costæ few, regular (10—11), and narrow, with regular elevated squamous folds in the left valve; the right valve undulated with wide depressed costæ crossed by densely arranged imbricated lamellæ; auricles large, unequal, lineated.

This shell, although so very abundant and well known, has nevertheless been confounded with another very distinct species by Goldfuss, tab. 90, fig. 8, where an elongated and convex shell, with few squamous costæ, has unfortunately received this appellation; this latter shell, which is from the Lias of Bavaria, has only a remote resemblance to *Pecten vagans.* The costæ of the left valve are regular, symmetrical, and have the elevated plicæ upon their surface regularly and rather closely arranged, the interstitial spaces are narrow and slightly impressed with the plications; the surface of the other valve is nearly destitute of costæ, and exhibits them faintly only and near to the border. It is rare in the Upper Ragstones of the Inferior Oolite, but very abundant throughout the Fuller's-earth and Great Oolite, and is usually accompanied by *Ostrea acuminata* and *Avicula echinata.* It occurs also in the Cornbrash near Chippenham, Wiltshire.

Pecten Woodwardii. Tab. I, fig. 20.

Testâ æquivalvi suborbiculari, convexâ, auriculis magnis inæqualibus, tenuissimé striatis; costis magnis radiantibus rotundis arcuatim divergentibus (*circa* 40 *in ambitu*), *interstiis angustis conformibus.*

Shell equivalve, suborbicular, convex; auricles large, unequal, and finely striated; costæ large rounded, radiately diverging (about 40 in the circumference), interstitial spaces narrow and conformable.

The anterior auricle is very large, the posterior one small; the costæ are regular, rounded, and closely arranged, the convexity of the valves is so considerable that the diameter through both is nearly equal to the lateral diameter. The general aspect is sufficiently distinct from all the associated species; *Pecten arcuatus*, which has the costæ similarly disposed, has a figure much less convex and orbicular, and the interstitial spaces are punctated.

Locality. This species is not unfrequently found in the white stone of Bussage and Eastcombs, bordering upon Bisley Common, and we are not aware that it has been found at any other locality.

The name from Mr. S. P. Woodward, of the British Museum, to whom it is dedicated.

PECTEN PEREGRINUS. Tab. I, fig. 14.

? Var. of PECTEN VAGANS, *Sow.*

Testâ inæquivalvi, ovato-orbiculari, auriculis magnis inæqualibus costellatis; valvâ sinistrâ subplanâ, costis radiantibus angustis, plicatis (*circa* 9), *intervallis inæqualibus, nonnunquam costulis interstitialibus evanescentibus hinc et inde dispositis. Valvâ dextrâ convexâ lamellis tenuissimis concentricis imbricatis, et sulcis magnis radiantibus* (*circa* 10).

Shell inequivalve, ovately orbicular, auricles large, unequal and costellated; left valve rather flattened, radiating costæ (about 9) arranged at irregular distances, narrow, nearly equal, with small and irregular plications; there are likewise two or three small interstitial lines or elevations upon the anterior side of the valve. Right valve convex, with very fine concentric and imbricated lamellæ; radiating sulcations (about 10) large and rather irregular.

The irregular distances at which the four anterior costæ of the left valve are placed, their narrow figure and small plications, will serve to distinguish it from *Pecten vagans*, the great convexity and obliquity of the other valve will equally distinguish it from *Pecten fibrosus*. It occurs somewhat rarely in the shelly beds of the Great Oolite.

Localities. Minchinhampton and Bisley Commons.

PECTEN RETIFERUS. Tab. I, fig. 15, 15*a*.

Testâ ovato-orbiculari, convexo-planâ, auriculis magnis subæqualibus reticulatis; lineis radiantibus elatis numerosis, irregularibus, aliis concentricis et elatis paucioribus decussatis.

Shell ovately orbicular, moderately convex, auricles large, nearly equal and reticulated; with radiating lines, elevated, numerous and somewhat irregular, crossed by others elevated and rounded but of unequal size and more distant.

The surface is crossbarred and somewhat rugose, the concentric lines in the more

advanced stage of growth being very prominent, unequal, rather irregular, and commonly covered with adherent shells; some slight undulations or irregularities are visible upon both descriptions of lines; young individuals are more depressed and ovate, their lines are very regular and distinct. It occurs not uncommonly in the planking beds throughout the Minchinhampton district, but the surfaces of the valves are frequently much obscured by adherent shells and adventitious matter entangled in the crossbarred surface. Height, 23 lines; lateral diameter, 21 lines.

Localities. Minchinhampton and Bisley Commons.

PECTEN HEMICOSTATUS. Tab. I, fig. 16.

? Var. of PECTEN VAGANS, *Sow.*

Testâ ovato-orbiculari inæquivalvi subæquilaterâ, valvâ sinistrâ convexâ, lineis radiantibus irregularibus et lamellis concentricis crebris ornatâ; ætate adulto costis radiantibus magnis (5) *distantibus plicis magnis instructis; intervallis latis, costulis minoribus interdum evanescentibus. Valvâ dextrâ depressâ, lamellis concentricis crebris, interdùm interruptis, et sulcis radiantibus leviter impressis. Auriculis magnis inæqualibus, costellatis.*

Shell inequivalve, nearly equilateral, ovately orbicular, the left valve convex, with numerous irregular radiating lines crossed by closely arranged concentric lamellæ; the adult condition has the valve more convex, with five large elevated plicated and distantly arranged radiating costæ; the intervals are wide, each having a supplementary costa more or less distinctly marked. The right valve is much more flattened, with concentric densely arranged lamellæ, sometimes interrupted, and a few radiating sulcations, which are so faintly impressed, that they are only visible near to the lower border. Auricles large, unequal, and costellated.

The surface of the convex valve in progress of growth undergoes a striking change; in the young state it is beautifully reticulated, but has no indications of the costæ which afterwards distinguish it; the adult shells have a form more convex, with five prominent radiating costæ, of which those at the sides are the smaller; the costæ have a few large irregular plications; it is only shells of the largest size that have a supplementary costa in each of the interstitial spaces. The imbricated lamellæ of the right valve are more prominent than those of *Pecten vagans,* and the sulcations are much less strongly impressed, so that they can only be discovered by a close examination. It occurs not unfrequently in the shelly beds of the formation; but, from the general coarseness of the deposit, the more delicate features of the surface are rarely preserved. The right valve is delicate, and few specimens have been distinguished.

Locality. The Minchinhampton district of the Great Oolite, throughout the shelly beds.

PECTEN PERSONATUS, *Goldf.*? Tab. I, fig. 17.

? PECTEN PERSONATUS, *Goldfuss.* Petref., p. 75, t. 99, fig. 5.

Testâ inæquivalvi, æquilaterali, sub-orbiculari, convexo-planâ, pellucidâ, interné (12—14) *costatâ; valvâ sinistrâ costis externis minutis crebris lineis concentricis decussatis; dextrâ lævi, auriculis inæqualibus obtusangulis costatis.* (Goldfuss.)

Shell inequivalve, equilateral, sub-orbicular, slightly convex, pellucid, its inner surface having costæ (12—14), left valve with very numerous external irregular radiating costæ, decussated by closely arranged concentric lines; the right valve smooth, its auricles unequal, obtusely angulated and costated.

It is only when the matrix consists of very fine sediment that the surface markings of this small and delicate shell can be distinguished; it is consequently rarely obtained. The specimens recorded by Goldfuss were found in the Inferior (*eisenschüssigen*) Oolite of Grafenburg and Besançon.

This species differs somewhat from the figure of Goldfuss, in having the longitudinal striation on the ears more prominent.

Localities. Minchinhampton and Bisley Commons in the Great Oolite; it occurs also in the Inferior Oolite of the same district.

PECTEN ARCUATUS, *Sow.* Tab. I, fig. 18.

PECTEN ARCUATUS, *Sow.* Min. Con., t. 205, f. 5—7, 1818.
— — ? *Goldfuss.* Petref., p. 50, t. 91, f. 6.
? Var. of PECTEN LENS, *Sow.*, fide *Bronn* and *Phillips.*

Testâ ovato-orbiculari, convexo-planâ, æquivalvi, costellis radiantibus confertis, arcuatim divergentibus, hinc inde dichotomis, striis interstitialibus punctatis; auriculis inæqualibus costellatis.

Shell ovately orbicular, slightly convex, equivalve, with radiating, depressed little ribs closely arranged, diverging with a curvature and sometimes dichotomous, the interstitial spaces punctuated; auricles unequal, ribbed.

The radiating ribs are moderately broad, but much depressed, and undulate rather irregularly where they are crossed by the few concentric folds of growth. This species occurs rarely in the shelly beds of the Great Oolite.

Localities. Bussage or Bisley Common; Stonesfield, Oxfordshire.

PECTEN LENS, *Sow.* Tab. II, fig. 1, 1*a*.

PECTEN LENS, *Sow.* Min. Con., t. 205, f. 2, 3, 1818.
— — *Goldfuss.* Petref., p. 49, t. 91, f. 3.
— — *Zieten.* Wurtt., p. 69, t. 52, f. 6.
— — *D'Orb.* In Murch. Russia, &c., ii, p. 476, t. 42, f. 1, 2.
— — *Quenstedt.* Wurtt., pp. 337, 538, 544.
— — *Bronn.* Leth. Geog., p. 206, t. 19, f. 7.
? PECTEN ANNULATUS, *Sow.* Min. Con., t. 542, f. 1.
— — *Goldfuss.* Petref., p. 49, t. 91, f. 2.

Testâ obliquâ, ovato-orbiculari, plano-convexâ, sub-æquivalvi, reticulatâ, lineis confertis concentricis et radiantibus arcuatim divergentibus, hinc inde furcatis; auriculis inæqualibus reticulatis.

Shell oblique, ovately orbicular, moderately convex, equivalve, radiating lines narrow, closely arranged, irregular, curving outwards, the interstitial spaces densely punctated or reticulated, occasionally bifurcated; concentric lines irregular; auricles unequal and reticulated.

There does not seem to be any sufficient or constant character which will enable us to separate this species from the *Pecten annulatus* of the Mineral Conchology and of Goldfuss; both have occasionally a certain degree of obliquity; the radiating lines of both are reticulated and bifurcated, becoming almost evanescent in the ultimate stage of growth; in the latter condition, the concentric elevated lines become constant, are much more prominent than the radiating lines, and do not furnish any peculiar or characteristic feature, we are therefore inclined to reunite the two species, and regard the annulated form to be merely a variety of the present one. Next to the *Pecten vagans*, this ranks as the most abundant *Pecten* of the Great Oolite, its vertical range is likewise remarkable, as it is found throughout the rocks of the entire Oolitic system; but attains its greatest development of size in the Coralline Oolite of Malton.

Localities. Wherever the Great Oolite is fossiliferous.

PECTEN ANNULATUS, *Sow.* Tab. I, fig. 13.

? Var. of PECTEN LENS.
PECTEN ANNULATUS, *Sow.* Min. Con., t. 542, f. 1, 1826.
— — *Goldfuss.* Petref., t. 91, f. 2.
— OBSCURUS, *Sow.* Min. Con., t. 205, f. 1.?

Testâ ovato-orbiculari, sub-æquivalvi, convexo-planâ, striis radiantibus subtillissimis, inæqualibus arcuatim divergentibus, lineis aut lamellis concentricis distantibus interruptis; auriculis inæqualibus striatis.

Shell ovately orbicular, nearly equivalve, rather depressed, radiating striations very fine, unequal, densely arranged, and diverging, the striations are broken and interrupted by prominent concentric lamellæ, which are rather distantly arranged; auricles unequal, striated.

The apicial portion of the shell is destitute of the concentric lamellæ, which commence abruptly and continue to the lower border of the shell. It occurs commonly in the Cornbrash, Forest Marble, and in the upper portion of the Great Oolite; but is not found in the shelly beds of the Michinhampton district.

Localities. Near Cirencester, and at Sapperton Tunnel, Gloucestershire; in the upper beds of the Great Oolite, at Blisworth, Kingsthorpe, and other places in Northamptonshire and Lincolnshire; it occurs also in the Stonesfield Slate.

PECTEN CLATHRATUS, *Roemer*. Tab. I, fig. 19, 19*a*.

PECTEN CLATHRATUS, *Roemer*. Verst. Nordd. Oolith., t. 13, f. 9, 1836.

Testâ ovato-orbiculari sub-æquivalvi, tenui plano-convexâ; auriculis magnis inæqualibus, valvâ sinistrâ convexiorâ; lineis radiantibus granulosis crebris inæqualibus et irregularibus, lineis concentricis obsoletis decussatis. Valvâ dextrâ lineis radiantibus remotioribus et irregularibus, lineis concentricis clathrato-nodosis.

Shell ovately orbicular, subæquivalve, thin, rather flattened, auricles very large, unequal, and striated; left valve moderately convex, with radiating densely arranged granulated lines, irregular and unequal, crossed by very obscure closely arranged concentric lines, for the most part obsolete. Right valve more flattened, radiating lines more remote, but unequal and irregular, nodose where they are crossed by regular and distinct lines constituting a finely cancellated surface.

This very delicate and elegant species has the anterior auricles remarkably large; the right valve varies very considerably in the close arrangement of the radiating lines, and in their prominence; the concentric lines are very irregular, unequal, and uncertain in their prominence, so that many specimens which appear shining and smooth to the unassisted vision, disclose, under a magnifier, a very perfect and distinctly ornamented surface. Its entire aspect is sufficiently characteristic to render it easily distinguishable from contemporaneous species.

Height, 18 lines; lateral diameter, 16 lines.

Localities. Minchinhampton and Bisley Commons, in the shelly beds of the formation.

HINNITES, *De France*, 1831.

Gen. Char. Shell ovate, sometimes oblique, irregular, inequivalve; umbones depressed, approximate; auricles unequal, posterior auricle small, sometimes nearly obsolete, anterior auricle produced; left valve convex, right valve flattened, delicate, adherent. Hinge straight without teeth, with a mesial trigonal fossa, as in *Pecten*. The surface is ornamented with radiating, imbricated, or nodulated costæ.

There is usually some degree of obliquity in the valves; the convex valve is never adherent, the other constantly so, which together with its extreme delicacy will account for it having been so rarely discovered.

The shells of this genus have been described as *Spondylus* by Goldfuss, but they are really very distinct from that genus; the extreme delicacy and irregularity of the valves would lead us to the distinction, irrespective of the hinge characters which are equally distinct from those of *Spondylus*.

The finest examples of this genus are found in the Inferior Oolite, both in number, dimensions, and variety of ornament.

HINNITES VELATUS, *Goldf.*, Sp. Tab. II, fig. 2.

PECTEN VELATUS, *Goldfuss.* Petref., t. 90, f. 2.
— —. *Roemer.* Verst., p. 67.
SPONDYLUS VELATUS, *Goldfuss.* Petref., t. 105, f. 4.

Testâ ovato-orbiculari convexâ, auriculâ anticâ magnâ costellatâ, posticâ parvâ, subobsoletâ; costellis radiantibus (*circa* 30) *nodulosis, subæqualibus, distantibus; interstitialibus lineatis; lineis nodulosis irregularibus. Valvâ dextrâ planatâ costellis lineisque ornatâ.*

Shell ovately orbicular, rather oblique, convex, anterior auricle large, posterior small, nearly obsolete, radiating little costæ (about 30 in the circumference) nodulated, nearly equal, and distantly arranged; the interstitial spaces have unequal and irregular nodulated lines, from one to three, being contained in each space. The right valve is flattened and ornamented in a manner similar to the other.

This species would appear to have a considerable range, both stratigraphically and geographically; it occurs in the shelly freestone beds of the Inferior Oolite, in the Fullers-earth, Great Oolite, Forest Marble, and Cornbrash.

Localities. Leckhampton Hill, the Sapperton Railway Tunnel, the entire Minchinhampton district of the Great Oolite, and in Northamptonshire and Lincolnshire.

HINNITES TEGULATUS. Tab. II, fig. 3, 3*a*.

Testâ ovato-orbiculari convexâ; valvâ sinistrâ auriculâ anticâ magnâ; posticâ subnullâ; costellis radiantibus (32—34) *tenuibus, regularibus transversé plicatis; plicis vel tegulis concentricis crebris subæqualibus interruptis.*

Shell ovately orbicular convex, the left valve with a large posterior auricle, anterior auricle obsolete; radiating little ribs (32 to 34 in the circumference,) fine, regular, and transversely plicated; plications concentric nearly equal, closely arranged but occasionally interrupted.

The radiating little ribs are delicate, regularly arranged, and impressed by the concentric plications, they are prominent about the middle of the valve, and become finer towards the sides; the right valve is unknown. The figure presents an approximation to that of *H. velatus*, but it appears to have more convexity and less obliquity; moreover the character of the surface, with its fine regular distinct radiating ribs, is very different from the irregularity observable in the other species. Height, 10 lines; lateral diameter, 8 lines.

Locality. Minchinhampton Common. Rare.

PLICATULA. *Lamarck*, 1801.

Gen. Char. Shell adherent, inequivalve, irregular, not eared, umbones terminal and pointed, no external area; ventral margin rounded, and more or less plicated. Hinge with two large diverging cardinal teeth in each valve, the teeth are striated laterally, and there is a conical fossa between them to receive the ligament, which is almost internal.

PLICATULA TUBERCULOSA. Tab. II, fig. 4.

Testâ ovato-orbiculari subobliquâ, convexo-planâ tuberculis obtusis numerosis in lineis radiantibus feré dispositis; umbonibus lævigatis sine tuberculis.

Shell very irregular, ovately orbicular, rather oblique, and depressed with numerous obtuse tubercles, for the most part disposed in radiating imperfect lines, umbonal extremity smooth, destitute of tubercles.

The round blunt warty tubercles have an aspect very different from the spines, either fistulous or pointed, with which the *Plicatulæ*, are for the most part furnished. The tubercles usually increase in size towards the ventral border of the valve, but in a very irregular manner, which, together with the very unequal and irregular surface of the valve, produces a very confused appearance; thus it happens that no two specimens can be found which nearly resemble each other; occasionally, the tubercles may be discovered approximating to the fistulous character; the margins of the valves are plicated in a very irregular manner. It is somewhat rare, but occurs in several of the shelly beds.

The two diameters across the valves are nearly equal, and rarely exceed 10 lines.

Localities. Minchinhampton and Bisley Commons.

PLICATULA FISTULOSA. Tab. II, fig. 5.

Testâ ovato-orbiculari depressâ, costulis fistulosis radiantibus irregularibus interstitialibus profundis.

Shell ovately orbicular depressed, costæ radiating irregular, with numerous irregular prominent fistulous spines; interstitial spaces deep.

About 12 or 13 costæ are distributed around the circumference of the valve; owing to the delicacy of the test, it is very rarely that a perfect specimen can be obtained.

Locality. Minchinhampton Common.

AVICULA, *Lam.* 1801.

Gen. Char. Shell inequivalve, eared, base transverse, straight, its extremities produced and forming auricles, left valve convex, umbone prominent; right valve smaller, flattened, its umbone depressed, and nearly obsolete. Hinge linear with a small indistinct tooth in each valve beneath the umbones, and a lengthened marginal ligamentiferous area. One rounded subcentral muscular impression in each valve, with a series of smaller ones in a line near the umbones.

AVICULA COSTATA, *Sow.* Tab. II, fig. 6, 6*a*.

AVICULA COSTATA, *Sow.* Min. Con. t. 244, f. 1, 1819.
— — *Smith.* Strat. Syst., pp. 67, 81.
— — *Ib.* Strata Ident. Clay over the Upper Oolite, f. 8.

Testâ convexâ oblique-ovatâ, auriculis parvis subæqualibus, umbonibus prominulis, costis (circa 18), *radiantibus equalibus rotundis, distantibus, interstitiis planis, latis et lævigatis.*

Shell convex obliquely ovate, auricles small, nearly equal, umbones prominent, costæ (about 18), radiating, equal, rounded and distant, the interstitial spaces flattened, wide and smooth.

This shell, so characteristic of the Bradford clay of Wiltshire, occurs very rarely in the shelly beds of the Great Oolite, and these are of very diminutive size.

Locality. Minchinhampton Common.

AVICULA ECHINATA, *Sow.* Tab. II, figs. 7, 7*a*.

AVICULA ECHINATA, *Sow.* Min. Con., t. 243, 1819.
— — *Smith.* Strat. Syst., p. 67.
— — *Ib.* Strata Ident., p. 26; Cornbrash Plate, f. 8.
? Var. AVICULA TEGULATA, *Goldfuss.* Petref., ii, p. 132, t. 121, f. 6.

Testâ ovato-obliquâ, auriculis equalibus parvis, valvâ sinistrâ convexâ costulis radiantibus numerosis, aliis minoribus interstitialibus alternatis, et lineis transversis decussatis nodis formante. Valvâ alterâ subplanâ, lævigatâ, lineis radiantibus tenuissimis subobsoletis.

Shell ovately oblique, auricles equal and small; left valve convex, with numerous radiating ribs, alternating with a smaller series in the interstitial spaces, and decussated by transverse, rather distant, regular lines, which form little knots as they pass over the costæ; the knots are more elevated, and closely arranged upon the anterior side of the shell. The other valve is nearly flat, smooth, with very fine distant and rather indistinct radiating lines.

This species is moderately common in the shelly beds of the Great Oolite, but the valves are always disunited, and its state of preservation very inferior to specimens obtained from the clay beds of the Fullers-earth, the Bradford Clay, or the Cornbrash, for its vertical range is very considerable.

Localities. Wherever the Great Oolite is shelly. Other geological positions are the Fullers-earth clays, of the Cotteswolds; likewise in the clays of the Cornbrash, the Forest marble, and the Bradford clay of Wiltshire; and also at Pavingham and other places in Bedfordshire.

Sub-Genus—PTEROPERNA.

Testâ subæquivalvi inæquilaterâ, utraque latere alatâ, alâ anticâ brevi, posticâ productâ, et marginatâ.

Margo cardinalis rectis, plus minusve obliquis, areâ ligamenti internâ, elongatâ, margini externi parallelâ.

Cardo dentibus infra umbonem numerosis angustis parallelis et minutis antrorsum vergentibus et costis posticis elongatis margine cardinali parallelis.

Umbones anteriores parvi depressi. Impressiones musculares duæ, in utraque valvis anticis parvis, posticis magnis ellipticis.

Facies externa sulco longitudinali elongato, sub-marginem cardinalem sitam.

Shell nearly equivalve, inequilateral, both extremities winged, anterior wing short, posterior elongated, its extremity marginated.

Hinge margin straight, more or less oblique, ligamental area internal, and nearly parallel with the external margin. Hinge with numerous very small parallel teeth placed beneath the umbones near to the anterior extremity of the shell, and one or two posterior or internal costæ, which are elongated and extend posteriorly nearly parallel with the hinge margin. Umbones anterior, small and depressed. Muscular impressions two in each valve, of which the anterior or byssal are very small; the posterior expanded, elliptical, and not strongly marked. External surface either ornamented or plain, having an elongated longitudinal groove extending posteriorly to the umbo, and parallel with the hinge margin in each valve.

This remarkable Oolitic form replaces and represents the genus *Pterinea* of the Palæozoic formations; its affinities to that genus are so evident, that it is necessary to inquire whether *Pteroperna* should be arranged as a sub-genus of *Pterinea* only, or is entitled to rank as a distinct genus. The principal distinguishing features are internal. In *Pterinea* the posterior elongated accessory ribs or teeth proceed obliquely downwards towards the inferior and posterior extremity of the valves, as far as the border of the large posterior muscular impression, at the anterior side of which they terminate abruptly; the muscular impression is angular, and extends upwards nearly to the hinge margin posteriorly. In *Pteroperna*, on the other hand, the posterior costæ extend along the inner surface of the hinge margin, almost parallel with it, and are consequently placed upon the hinge plate above the muscular impression, which is rounded or elliptical, and placed lower or more nearly to the middle of the posterior surface. As minor points of distinction it may be mentioned, that in *Pterinea* the anterior teeth vary in number from two to four only; but in our typical shell, *Pteroperna costatula*, they are not less than sixteen, and are so minute that they scarcely occupy a greater longitudinal space than those of *Pterinea*. Externally our genus possesses a characteristic feature very convenient for the Palæontologist, who is rarely able to refer to the hinge, and which readily serves to distinguish it both from *Pterinea* and *Avicula;* we allude to the elongated posterior groove, which is always visible upon the surface, and of which the other two forms are destitute. Regarding, therefore, the position of the internal ligamental groove and accessory costæ, together with the form and position of the posterior muscular impression as indicating a corresponding difference in the structure of the animal, when compared with those parts of *Pterinea*, we consider ourselves justified in considering the Oolitic form as a genus distinct from but nearly allied to *Pterinea*.

Pteroperna also presents considerable analogy to the recent genus, *Malleus*.

PTEROPERNA COSTATULA, *Deslongchamps*, sp. Tab. II, figs. 8, 8*a*, 13, 13*a*.

GERVILLIA COSTATULA, *Deslongchamps*. Mém. Soc. Linn. du Calvados, 1824; tom. i, t. v, figs. 3—5.

AVICULA POLYODON? *Buvignier*. Mém. Soc. Philomath. Verdun, 1845, pl. iv, fig. 16.

Testâ obliquâ, lineâ cardinali recto, elongato, postico valde producto et emarginato, valvâ sinistrâ modico convexo, valvâ dextrâ subplanâ, umbone depresso, latere postico in utraque valvâ curvato aut excavato.

In ætate juniori, valvâ sinistrâ convexo-brevi, costulis radiantibus (6—8) *elatis, acutis subundulatis, et inæqualibus cum lineis transversis interstitialibus regularibus et tenuissimis.*

In ætate adultâ, valvâ sinistrâ sine costulis aut striis cum laminis incrementi paucis, distantibus. Valvâ dextrâ semper lævigatâ.

Shell oblique, hinge line straight, elongated, very much produced posteriorly and emarginated, left valve moderately convex, right valve more flattened, the umbo depressed; posterior side in each valve curved, its margin concave.

This species occurs under the following conditions of growth:—

In the young state, the left valve is very convex and short, having radiating costæ (6—8) elevated, acute, slightly waved and unequal, the interstitial spaces with regular, transverse, fine, closely arranged lines.

In the adult state, the left valve is without costæ or striæ, having only a few distant lines of growth. Were instances wanting to exemplify the advantage which is derived from the inspection of a large number of specimens in every stage of growth, undoubtedly the present species might be selected for such a purpose, the two extremes of growth presenting an aspect so dissimilar, that until numerous examples of every intermediate grade had been obtained, we hesitated with respect to their specific distinctness or identity; minute specimens occur in great numbers, having a length of only three or four lines; in these the costæ are always very prominent, the number of costæ vary from 6 to 8, they occupy only the middle portion of the valve, the sides being plain. The costæ continue distinct, but less conspicuous, when the shell has attained a diameter of 16 or 18 lines, but the costæ have then become waved, irregular, and unequal; beyond these dimensions, the valve is either plain, or has only faint indications of costæ, crossed and interrupted by laminæ of growth; but even in the ultimate stage of growth, when the hinge line has attained the length of five inches or upwards, and the test has acquired a considerable degree of thickness, the left valve has never so smooth a surface as the other, the last faint indication of its having previously possessed a sculptured surface. The specimens figured by M. Deslongchamps and M. Buvignier have only a very remote resemblance to each other, and tend to illustrate the foregoing remarks; *Gervillia costatula* is stated by the former author to have only four or five costæ, but the smaller number is probably owing to the less perfect state of the specimen, or to accident; in the

young state, the shell is thin and delicate, more especially the right valve; the latter is consequently comparatively rare; and M. Deslongchamps had not recognised it in Normandy, when he published his description of *Gervillia costatula* in 1824; at that period so few species of *Gervillia* were known, that the *usual* character of the surface could not be considered as ascertained, nor likewise the limits to which any variation in the hinge was restricted; but now that a considerable number are recorded, it will be found that in few instances where the hinge of *Gervillia* has been disclosed has a sculptured surface been coincident with it: the hinge of *Gervillia costatula* given by M. Deslongchamps, differs somewhat from our own, and from the figure of M. Buvignier; but as it is still more unlike the hinge of *Gervillia*, we might from the hinge alone conclude that it had been incorrectly allocated. The shell figured by M. Buvignier, though very imperfect, is readily recognised as our own species in the ultimate stage of growth, and having a degree of obliquity greater than is usual. It occurs in all the shelly beds of the Minchinhampton district, but specimens of the ultimate stage of growth have only been obtained in the planking of Minchinhampton Common. The same species, or one nearly allied to it, has also been procured, rarely, in the free-stone beds of the Inferior Oolite in the same district.

Localities. Minchinhampton; Ranville near Caen, Normandy; St. Mihiel, France.

PTEROPERNA PYGMEA, *Dunker*, Sp. Tab. II, fig. 11, 11*a*.

AVICULA PYGMEA, *Koch* and *Dunker*. Norddeuts. Ool. Versteinerungen, t. 3, f. 6.

Testâ parvâ, subæquivalvis, ovato-obliquâ, concentricè idque obsoletè striatâ; alâ anticâ rotundatâ, sinuatâ, posticâ excavatâ; umbonibus prominulis.

Shell small, subæquivalve, ovately oblique, concentrically, but obsoletely striated; anterior wing rounded and produced, its lower border sinuated, posterior wing excavated by a longitudinal furrow; umbones rather large and prominent, rising higher than the hinge line.

The right valve has a somewhat flatter surface than the other, and exhibits very slight traces of one or two longitudinal costæ; the transverse lines are not usually preserved, and are visible only upon a portion of one of our specimens.

Locality. It occurs somewhat rarely in the soft Oolite which overlies the Weatherstone Beds at Minchinhampton Common.

PTEROPERNA EMARGINATA. Tab. II, fig. 10.

Testâ subplanâ, ovato-elongatâ et obliquâ, valvâ sinistrâ lævigatâ, striis concentricis subobsoletis; alâ anticâ parvâ, posticâ emarginatâ. Valvâ dextrâ ignotâ.

Shell rather flattened, ovately elongated, and oblique; left valve smooth, with concentric and nearly obsolete striæ; anterior wing small and pointed, posterior emarginated. Right valve unknown.

The degree of obliquity and flatness is much greater than in the associated species, and the anterior wing is smaller; some traces of an elongated groove are visible upon the posterior wing of the left valve.

Locality. Minchinhampton Common, where it is very rare, and occurs in the bed of soft shelly Oolite which overlies the Weatherstones.

Gervillia, *Defrance*, 1820.

Gen. Char. Shell subæquivalve or inequivalve, inequilateral, elongated, transverse; hinge margin usually straight, lengthened, and oblique; umbones small, oblique, anterior, contiguous, rarely terminal; hinge linear, marginal, with many oblong parallel, but rather distant and irregular pits in each valve, placed transversely to the hinge line; internal hinge teeth parallel, oblique, placed anteriorly, or beneath the transverse sulci.

The increased number of species exhibit characters which render it necessary to arrange them under two sections.

a' Shell subæquivalve, margins of the valves regular.

b' Shell very inequivalve and irregular, more or less contorted; margins of the valves close fitting, but sinuated.

Section *a'* comprises the usual well-known subæquivalve species.

Section *b'* has for examples *G. monotis*, Deslong., *G. Hartmanni*, Goldf., and *G. tortuosa* the *Gastrochæna tortuosa* of Phillips.

Section *a'*.

Gervillia acuta, *Sow.* Tab. III, fig. 12, 12*a*.

Gervillia acuta, *Sowerby.* Min. Conch., t. 510, fig. 5, 1826.
— lanceolata, *Goldfuss.* Petref., t. 115, fig. 9.
? — acuta, *Phillips.* Geol. York., tab. 9, fig. 36, 1835.
? — siliqua, *Deslongchamps.* Mem. Soc. Linn. Calvados., t. 4, 1824.

Testâ lanceolatâ in vertice convexâ, margine cardinali perobliquo depresso, umbonibus angustis acutis foveolis (3) *quadratis.* (Goldfuss.)

Shell lanceolate, slightly curved, subæquivalve, anterior side moderately convex, posterior side compressed and attenuated; hinge margin very oblique, with three quadrate hinge pits; umbones attenuated, anterior auricle acute and pointed, posterior auricle forming an obtuse angle with the border beneath it; folds of growth irregular, strongly marked. Compared with *Gervillia monotis*, the valves will be found less contorted or more nearly equivalve, the hinge border shorter, and the posterior auricle is not produced as in that species; in common with other species, the right valve is thinner, smoother, and more flattened than the other.

Localities. It occurs in the Stonesfield slate of the Cotteswolds (Buckman). In the slaty Oolite of Collyweston, Northamptonshire.

GERVILLIA SUBCYLINDRICA. Tab. III, fig. 13, 13*a*, *b*.

? Var. of GERVILLIA ACUTA, *Sow.*

Testâ subæquivalvi, elongatâ, subcylindricâ, marginè cardinali majis obliquo; umbone in valvâ sinistrâ obliquo, prominulo, antico; valvæ dextræ umbone depresso, acuto. Cardo foveolis 3 *aut* 4, *dentibus internis tribus obliquis, anticis.*

Shell subæquivalve, elongated, subcylindrical; hinge line very oblique, lengthened, and nearly straight; umbo in the left valve oblique, prominent, but not terminal; right valve with the umbo depressed and acute; hinge with three or four marginal pits, and three oblique, anterior, and internal hinge teeth.

Without care this shell may be confounded with *G. aviculodes*, Goldfuss, t. 115, f. 8, but upon comparison the latter shell will be found wider, and the umbones straighter, and more acute; the hinge line also is inclined at a smaller angle, the general figure being less elongated and cylindrical. From *G. siliqua*, Deslongchamps, the very different inclination of the hinge line and straighter form will distinguish it.

Locality. Minchinhampton Common, where it occurs somewhat rarely in the planking.

GERVILLIA BATHONICA. Tab. II, fig. 15.

Testâ oblongâ, planatâ, subæquivalvi, umbonibus terminalibus acutis, margine cardinali recto, obliquo, (plerumque ad angulum 45 *gradum inclinantibus,) latere antico recto interdum subexcavato, basi curvatâ; foveolis* (9) *oblongis, æqualibus et regularibus; dentibus cardinis interné duobus, obliquis, anticis.*

Shell oblong, flattened, subæquivalve; umbones terminal and acute; hinge line straight, oblique, (for the most part inclined at an angle of 45 degrees,) anterior side straight, sometimes rather excavated, base rounded; hinge pits oblong (nine in number), equal and regular; internal hinge teeth two, anterior, and oblique.

The figure varies so considerably, that but for the inspection of a considerable number of examples of all stages of growth, they would probably be separated into at least two species, hardly two specimens, indeed, can be found exactly alike in the figure of the anterior margin, the angle at which the hinge is inclined, the degree of convexity in the valves, or in the general length of the figure.

The terminal position of the umbones together with the straight or even slightly concave figure of the anterior margin gives to it very much the figure of *Perna*, but the large oblique internal teeth in the hinge, and absence of the anterior hiatus or corrugation, effectually separates it from that genus.

Its habits were eminently gregareous, and in certain layers of the white stone at Bussage and Eastcombs, it occurs in great numbers to the exclusion of nearly every other species; but even in these circumstances, the valves are very rarely found in apposition,

and the usual length is about an inch; it occurs, however, in all the shelly beds of the Minchinhampton district.

In examining approximate species it will be found that the figure is less quadrate than *Perna quadrata*, Phillips; the terminal umbones separate it from *Gervillia acuta*, Goldfuss; and from *Perna mytiloides*, Goldfuss, the straightness of the hinge line is a point of distinction.

Locality. Minchinhampton.

GERVILLIA OVATA, *Sow.*, Sp. Tab. II, fig. 12, 12*a*.

AVICULA OVATA, *Sow.* Min. Con., t. 512, f. 2, 1826.

Testâ ovato-obliquâ, convexâ et lævigatâ, valvâ sinistrâ convexâ, umbone obliquo, mediano, margine cardinali brevi, subrecto, margine antico rotundo; auriculis submellis, valvâ dextrâ plano-convexâ, umbone parvo. Sulcis cardinis externé tribus, magnis, distantibus et irregularibus; dentibus cardinis interni subobsoletis.

Shell ovate, oblique, convex, smooth; left valve with the umbo oblique, nearly mesial; hinge line nearly straight, short, the anterior extremity rounded, auricles small; right valve more flattened, the umbo small; external sulci of the hinge three, large, wide, distant and irregular; internal hinge teeth scarcely distinguishable.

The valves are always separated and delicate, the test being usually but imperfectly preserved; the younger specimens are shorter in proportion, and the hinge line exceeds half the length of the valves; but in others of large dimensions it is less than half the length. Owing to its delicacy it is seldom that the hinge can be exposed, but independently of this, it entirely wants the anterior hiatus and corrugation which exists in *Avicula* and *Perna*, from the latter genus, indeed, the character of the surface is different, and it does not possess the squamous structure of the *Pernæ*.

Localities. The whole of the Minchinhampton district, in the shelly beds of which it is moderately common, more especially about the middle of the shelly series. Also at Stonesfield, Oxfordshire.

Section *b'*.

GERVILLIA MONOTIS, *Deslongchamps.* Tab. II, fig. 14, 14*a*, *b*.

GERVILLIA MONOTIS, *Deslongchamps.* Mem. Soc. Linn. Calvados, tom. i, 1824, t. 5, f. 2.

Testâ elongatâ, subarcuatâ, valvâ sinistrâ convexâ; umbone antico, subterminali; laminis incrementi impressis; valvâ dextrâ planâ, interdum concavâ, umbone terminali, depresso et acuto; margine cardinali obliquo in auriculo postico acuto, producto. Cardine foveis (5) *subremotis, dentibus interni duobus, magnis, anticis.*

Shell elongated, somewhat bow shaped, left valve convex; umbo anterior, oblique, almost or completely terminal, prominent, and impressed with laminæ of growth; right

valve flat, sometimes concave, its umbo terminal, depressed, and acute; hinge line very oblique, elongated posteriorly, and produced into an auricle. Hinge with five large and rather remote sulci; internal teeth two, large and anterior, margins of the valves sinuated.

This species forms a link connecting two very dissimilar groups of *Gervilliæ;* it possesses the characteristics of the second or contorted group in a more modified form than *G. Hartmanni*, Goldfuss, or *G. tortuosa*, the *Gastrochæna tortuosa* of Phillips; these two latter species pertain to the Inferior Oolite, and the present one to the Great Oolite. The degree of contortion varies considerably in individuals; the young specimens have a very lengthened hinge line; the lines of growth are strongly marked upon the left valve, and there are two short obscure ribs diverging from the umbo, these, however, disappeared in the progress of growth, and the posterior extremity became more produced.

The right valve is more delicate, and is found more rarely than the other; the same circumstance occurs likewise in Normandy, where M. Deslongchamps had not seen the right valve when he described this species. It ranks as one of the most abundant and characteristic bivalves of the Great Oolite; it occurs indifferently in all the shelly beds.

Localities. Minchinhampton; Normandy.

GERVILLIA CRASSICOSTA. Tab. II, fig. 9.

Testâ valde obliquâ, elongatâ, convexiusculâ, auriculo antico rotundato, postico truncato et brevi; costis radiantibus subundatis, elatis majoribus 8, *alternatim minoribus, et cum striis transversis numerosis, indentatis, latero postico elongato: valvâ dextrâ ignotâ.*

Shell very oblique, elongated, convex, anterior auricle rounded, posterior auricle short and emarginated; radiating costæ slightly waved, elevated, the larger 8 in number, distant, and alternating with as many smaller, and impressed with numerous rather indistinct transverse striæ: posterior and inferior extremity elongated and slightly acuminated: right valve unknown.

Of this rare species we have only obtained three examples; the hinge border is much shorter than in *Pteroperna costatula*, the posterior wing being but little produced; the whole contour of the shell is very oblique, and the larger costæ are very prominent; the greater degree of obliquity, convexity, and alternation of the costæ, readily serve to distinguish it from *P. costatula.*

Locality. Minchinhampton Common.

GERVILLIA RADIANS. Tab. VI, fig. 10.

Testâ magnâ crassâ inæquivalvi valde contortâ, valvâ sinistrâ arcuatâ, umbone magno incurvo, valvâ dextrâ oblique-concavo, umbone depresso; margine cardinali elongato subhorizontali, auriculis prominulis; lateribus lineis radiantibus paucis obscuris; aliis concentricis dense dispositis.

Shell large, very thick, inequivalve, very much contorted, the left valve very convex,

arched, with the umbo large and incurved; right valve oblique and concave, its umbo depressed; hinge margin elongated, nearly horizontal, with prominent auricles; the surface of the convex valve has a few obscure radiating lines decussated by others, which are concentric, irregular, and very densely arranged.

The general aspect has a considerable resemblance to *Gervillia Hartmanni* (Goldfuss), but it is more contorted than that shell; the valves are shorter, the diameter through them is greater, and the hinge line is so much less oblique as to be nearly at right angles to the axis; owing to this figure and the length of the hinge line, the posterior auricle projects considerably.

Locality. Morcot, Rutlandshire.

Inoceramus. *Park.* 1811.

Inoceramus, Catillus, Mytiloides, *Brong.*

Gen. Char. Shell inequivalve, sub-equilateral, ovately trigonal, umbones prominent, incurved; hinge straight, nearly horizontal, consisting of a series of transverse parallel teeth in each valve; substance of the test fibro-lamellar.

Inoceramus? obliquus. Tab. VI, fig. 12.

Testâ ovato-obliquâ subdepressâ, subæquivalvi, umbonibus prominulis subæqualibus, margine cardinali brevi obliquo, margine anteriore et inferiore curvato, posteriore subsinuato; lateribus plicis concentricis elatis, angustis inæqualibus et irregularibus, interdum sub-acutis.

Shell ovate, oblique, rather depressed, subæquivalve, umbones prominent, nearly equal, hinge margin short, oblique, anterior and inferior margins gracefully rounded, posterior border slightly sinuated; the sides of the valves concentrically plicated; the plications are elevated and narrow, irregular and unequal, sometimes acute; the substance of the shell is thin. It is more oblique, wider, and less pointed than the *I. cinctus* from the Oolite of Ireland, and more depressed than any other Oolitic species with which we have compared it; the valves are thin, frequently in opposition, and are more or less compressed and distorted; the surface is smooth, shining, and is destitute of any striations.

Length, $2\frac{3}{4}$ inches; breadth, $2\frac{1}{4}$ inches; diameter through both the valves about $1\frac{1}{4}$ inch.

Locality. Morcot, Rutlandshire.

Inoceramus Fittoni. Tab. IV, fig. 14.

? Inoceramus amydaloides, *Goldf.* Pet., t. 115, f. 4.

Testâ tenui ovato-acutâ depressâ: margine cardinali obliquo posteriore subrecto; umbonibus subacutis, rugis concentricis inæqualibus et irregularibus.

A somewhat oval, depressed, and thin shell, with the hinge margin oblique, and rather prominent umbones; surface irregularly undulated.

A shell presenting considerable resemblance in form to *I. amydaloides*, Goldf., but we have only been enabled to compare it with casts of that species which is found in the Lias of Germany.

Locality. Stonesfield, Oxfordshire, where it occurs but rarely.

Perna, *Brugière*, 1791.

Gen. Char. Shell flattened somewhat irregular, with terminal depressed umbones, hinge linear marginal, with numerous parallel ligamental pits; byssal sinus anterior placed a little beneath the umbones, and slightly gaping, its margins thickened; muscular impression oval and situated rather posteriorly; texture of the shell fibro-lamellar.

Perna rugosa. Tab. III, fig. 1.

? Perna rugosa, Goldf. Petref. 2. t. 108, f. 2.

Testâ subquadratâ, complanatâ, rugosâ, tenui, umbonibus acutis, lineâ cardinali horizontali; laminis superficiei scabris irregularibus.

Shell subquadrate, flattened, rugose, thin, with acute umbones, hinge line horizontal and of moderate length; laminæ of the surface rough and irregular.

The general figure possesses a considerable resemblance to *P. rugosa*, Munst. (Goldf. Petref., t. 108, fig. 2,) our specimen is, however, more compressed, and the umbones less prominent, the test is also somewhat thin. The tenuity of the test affords a striking contrast to several massive Inferior Oolite species, whose general contour is not very dissimilar.

Locality. Minchinhampton Common, where it occurs very rarely in the bed of coarse planking. The *P. quadrata*, Phil. is probably identical with this species.

Lima, *Brug.*, 1791.

Plagiostoma, Sp., *Sow.*

Gen. Char. Shell subequivalve, inequilateral, oblique, aurited, hinge margin oblique, thickened within, forming a transversely flattened plate, in which and beneath the umbones is a triangular depression, destined to receive a ligament which is partly internal.[1]

[1] In an interesting communication read before the Linnean Society of alvados, (December, 1830,) Professor E. Deslongchamps stated the general reasons for uniting the species of *Plagiostoma* to *Lima*. In this memoir, not yet we believe fully published, M. Deslongchamps described seventeen species of *Lima* from the Jurassic strata of Calvados, and arranged them under four sections :—

1. Margins of the valves entire, not serrated, lunule distinct: *L. gigantea, heteromorpha.*
2. Margins of the valves sinuato-dentate, lunule distinct: *L. sulcata, variabilis, radiata, punctata.*
3. Margin of the valves serrated, lunule distinct: *L. elliptica, lucida, pulchella, uniaurita, typus, lævis, semistriata.*
4. Margins of the valves sinuato-angular, no lunule: *L. alternans, duplicata, gibbosa, exigua.*

It may be conveniently divided into the following groups:

a. Species with the umbones divergent, having between them a triangular area, borders of the valves rounded, lunule distinct and gaping.

b. Umbones approximate, borders of the valves rounded, lunule small and closed.

c. Species more flattened and elongated, or chisel shaped, the borders of the valves truncated, lunule gaping, its borders folded backwards.

d. Umbones approximate, borders of the valves truncated anteriorly, lunule closed.

Our Great Oolite species will be found to contain examples of each of the foregoing groups.

LIMA DUPLICATA, *Sow.*, sp. Tab. III, fig. 6, 6 *a.*

PLAGIOSTOMA DUPLICATA, *Sow.* Min. Con., t. 559, f. 3, 1827.
? — PECTENOIDES, *Zieten.* Wurtt., p. 92, t. 69, f. 2.
LIMA ALTERNICOSTA, *Buvignier.* Geol. de la Meuse, p. 22, t. 18, f. 11—13.

Testâ convexâ oblique-ovatâ, anticè abrupti truncatâ ad cardinem angustatâ, postici rotundatâ, auriculis parvis subæqualibus; costis 25—28 *angulatis, carinatis, sulcis conformibus in imo sulcorum costâ minimâ ornatis, costis tenuissime transversè striatis.*

Shell convex, obliquely ovate, anterior side abruptly truncate, narrow towards the hinge border, posterior border rounded, auricles small, nearly equal; costæ 25—28, angulated, elevated, the angle being crested with a very fine carina, interstitial spaces wide, conformable, each having a single very fine costa, the costæ and their carinæ are finely and densely striated transversely.

The costæ and sulcations are large upon the middle of the shell and become regularly smaller towards the sides, becoming ultimately only so many fine lines. It is distinguished from *Limea duplicata*, an Inferior Oolite species, by the more oblique form and less elevated and acute costæ. The *Lima alternicosta* of Buvignier, from the Ferruginous Oolite, in the Oxfordian strata of the Department of the Meuse, does not appear to differ from our species in any essential character, except that the figure he has given is somewhat more than usually oblique.

It is one of the most common bivalves in the formation, but it is not often that the fine longitudinal carina upon the costæ is preserved. Height, 14 lines; length, 9 lines.

Localities. The entire Minchinhampton district of the Great Oolite, also in the Bradford Clay, Forest Marble, and Cornbrash of Wiltshire and Gloucestershire.

(*c.*) LIMA PECTINIFORMIS, *Schloth.* Tab. VI, fig. 9.

OSTRACITES PECTINIFORMIS, *Schloth.* Petref., p. 231, 1820.
OSTREA PECTINIFORMIS, *Zieten.* Wurtt., p. 62, t. 47, f. 1.
LIMA PROBOSCIDEA, *Sow.* Min. Con., t. 264, 1821.
— — *Goldfuss.* Petref., p. 88, t. 103, f. 2.
— PECTINIFORMIS, *Bronn.* Leth. Geog., p. 214, t. 19, f. 9, 10, 1851.

Testâ convexâ suborbiculari subæquilaterali, concentrice lamelloso-rugosâ; costis (11—14,) *convexis nodosis tubuliferis, canalibus conformibus, auriculis anterioribus sinuosis hiantibus, lunulâ nullâ.* (Goldfuss.)

Shell convex suborbicular, nearly equilateral with concentric rugose lamellæ; costæ (11—14,) convex, with nodose and elevated prominent fistulous plications, interstitial spaces conformable; anterior auricles sinuated and gaping, no lunule.

This shell is well known as a constant fossil of the upper ragstones of the Inferior Oolite; it likewise occurs occasionally in the shelly beds of the Great Oolite, and is always very imperfectly preserved, most commonly, only the outer cast remaining, but it never attains the dimensions of the Inferior Oolite specimens, and would seem therefore to have degenerated both in size and thickness.

Locality. Minchinhampton Common.

(*d.*) Lima cardiiformis, *Sow.* Tab. III, fig. 2, 2 *a.*

Plagiostoma cardiiforme, *Sow.* Min. Con., t. 113, f. 3, 1815.

Testâ convexâ, oblique ovato-orbiculari; anticè truncatâ, costis crebris (*circa* 52—56), *convexis æqualibus, canalibus angustis, lineis transversis regularibus crassiusculis, lunulâ excavatâ.*

Shell convex, oblique, ovately orbicular, anterior side truncated, costæ numerous (about 52—56,) convex, equal, the interstitial spaces narrow, with transverse, regular, and prominent lines, lunule excavated.

The shell is moderately lengthened, the longitudinal always exceeding the lateral diameter, the degree of convexity though varying is considerable, the diameter through both the valves being about equal to two thirds of the length of the shell, the umbones are but slightly curved, and the lunule is but moderately excavated, the valves are closed at their anterior borders, or leave when united the least possible fissure, the hinge border slopes obliquely from the umbones on each side, and the auricles are small; the umbones are but slightly separated, the ligamental area being very contracted. The costæ are regularly rounded, and so closely arranged, as to leave the interstitial spaces deep and narrow, the surface (more especially in older specimens,) are rendered rugose by the transverse striæ, but in this feature, and likewise in the elevation of the ribs, there is much variety, but the number of the ribs is very constant, and assists to distinguish it from *Lima notata*, Goldfuss, in which they are much less numerous, and the interstitial spaces considerably wider, and the convexity of the valve is less; in other respects there is a considerable general resemblance between the two forms. This is the most universally distributed *Lima* of the formation, occurring in every variety of rock, whether composed of sandstone, clay, or shelly limestone.

Locality. Minchinhampton and Sapperton.

(*c.*) LIMA LUCIENSIS, *D'Orbigny*. Tab. III, fig. 4.

LIMA LUCIENSIS, *D'Orbigny*. Prodrome de Paléontologie, p. 313, 1850.

Testâ plano-convexâ, oblique elongatâ, umbonibus acutis depressis, approximatis, auriculis magnis subæqualibus; costis (10 *aut* 11) *magnis plicatis, interstitialibus conformibus.*

Shell compressed or rather convex, obliquely elongated, umbones nearly straight, pointed, and approximated, auricles large, nearly equal and costated longitudinally, the anterior auricle corrugated and gaping. Costæ upon the back of the shell (10 or 11) large, plicated, rounded, with large conformable interstitial spaces.

This species has less obliquity than is usual with the *Limæ*, and this character will always serve to distinguish it from *Lima angusta*, Buvignier, t. 18, f. 27, which occurs in the middle portion of the Inferior Oolite in Gloucestershire, the character of the costæ in that species is very similar but more curved, the shell is always very oblique, its anterior side or lunule being concave. Compared with *Lima substriata*, Goldfuss, our species is much more elongated, has fewer costæ, and has not the distinctly raised murications or plicæ by which the costæ of that species are ornamented. It is somewhat rare, but occurs in several of the shelly beds.

Locality. The Minchinhampton district.

(*d.*) LIMA GIBBOSA, *Sow.* Tab. III, fig. 7, 7 *a*.

LIMA GIBBOSA, *Sow.* Min. Con., t. 152, 1817.
— — *Bronn.* Leth. Geog., 213, t. 19, f. 11, 1851.
— — — Index Palæont., p. 645, (not Goldf.?)

Testâ convexâ ovato-subobliquâ, elongatâ, fornicatâ, umbonibus magnis approximatis, dorso costato; costis (11—13) *elevatis acutis, canalibus conformibus; striis tenuissimis, transversis decussatis.*

Shell ovate, slightly oblique, convex, elongated, ribbed, umbones large and contiguous, back of the shell with acute, elevated costæ from 11 to 13 in number, with conformable interstitial spaces; the entire surface has very fine transverse striæ.

The sides of the shell are destitute of costæ, the smooth surface being about equal in extent to that which is costated. This species is perfectly distinct from the *Lima gibbosa* of Goldfuss, which is more oblique, the costæ are curved, they extend even upon the posterior sides of the valves, and their number is more than twice as great as in our own or Sowerby's species. In the shelly beds of the Great Oolite it occurs very rarely in single valves, and never equalling half the size which it attains in the Inferior Oolite, but in the seams of clay which are associated with Stonesfield slate, casts are found of the full dimensions, and with the valves in apposition.

Localities. Minchinhampton Common; Ancliff, Wiltshire.

(*b.*) LIMA SEMICIRCULARIS, *Goldf.* Tab. III, fig. 3, 3 *a.*

LIMA SEMICIRCULARIS, *Goldfuss.* Petref., t. 101, f. 6.
PLAGIOSTOMA SEMICIRCULARIS, *Quenstedt.* Wurtt., p. 477.

Testâ convexâ, oblique semicirculari, anticè truncatâ, costulis crebris æqualibus convexis, canalibus interstitialibus angustioribus concentrice confertim striatis, lunulâ plano-concavâ.

Shell moderately convex, obliquely semicircular, anterior side straight, truncated, ribs closely arranged, very numerous, convex, the interstitial spaces more narrow, and impressed with very delicate striæ; lunule flattened, or slightly excavated, umbones approximated, pointed, auricles small, hinge border straight.

This species has some general resemblance to young specimens of *Lima cardiformis*, but may be distinguished from it by the more elongated, depressed, and less oblique form, and more especially by the more pointed and depressed umbones, the costæ also, contrary to that species, are often slightly undulated, and the lines of growth form two or three prominent rounded elevations. The average size is about an inch in length. It is moderately abundant in the shelly beds.

Locality. The whole of the Minchinhampton district.

(*c.*) LIMA OVALIS, *Sow.* Tab. III, fig. 5, 5 *a.*

PLAGIOSTOMA OVALIS, *Sow.* Min. Con., t. 114, f. 3, 1815.
LIMA OVALIS, *Goldf.* Petref., t. 101, f. 4.

Testâ convexâ oblique ovatâ, anticè truncatâ, costulis convexis æqualibus crebris, sulcis interstitialibus transversim lineatis, lunulâ concavâ.

Shell ovate, moderately convex, umbones pointed, auricles very small, anterior border nearly straight, the side steep and rounded, posterior border curved nearly in a semicircle; costæ convex, but very densely arranged, equal and marked with extremely delicate transverse striæ, the interstitial spaces are very narrow and punctated.

The costæ are equal and waved, but so fine as scarcely to be traced without the aid of a magnifier, the auricles in size are reduced almost to nothing. The general dimensions nearly accord with *Lima semicircularis*, but it is more convex and oblique, the anterior side being more steep and rounded.

Locality. It is not very abundant, but occurs throughout the shelly beds of the formation over the Minchinhampton district, and likewise at Ancliff.

(*d.*) LIMA IMPRESSA. Tab. III, fig. 8, 8 *a.*

Testâ convexâ obliquâ, ovato-orbiculari, anticè truncatâ, costulis depressis, irregularibus sulcis angustis interstitialibus undulatis, punctis crebris impressis, et striis transversalibus tenuissimis notatis. Striis incrementi paucis distantibus.

Shell convex oblique, ovately-orbicular, anterior side truncated, costæ depressed, of

irregular width, with very narrow and waved interstitial sulcations, which are impressed with densely arranged punctures; the surface of the shell has likewise very fine transverse striæ. Striæ of growth few and distant.

This shell is moderately convex, the lateral and longitudinal diameters are nearly equal, the umbones approximate and the auricles are small, the substance of the test is thin, and the surface, except in young specimens, is usually distorted or crushed, so that it is nearly impossible to obtain a large specimen which has not suffered in the process of fossilization. The longitudinal elevations are so slight as scarcely to be considered costæ, their surfaces are smooth, shining, and so much flattened, as scarcely to impress a sensible convexity to the touch. The numbers of the irregular costæ vary from 40 to 48, they are equally distinct upon every part of the shell, a feature which will always distinguish it from *Lima gigantea*, and analogous species. *Lima læviusculá*, Deshayes, approximates to our species, but is destitute of the dense punctations which mark the interstitial spaces; the interstitial sulcations are likewise evanescent upon the middle of the valves, which is not the case with our shell. *Lima aciculatá*, Goldfuss, approaches this species in the character of its markings, but it is much more flattened, and the costæ are regular and more numerous.

This species is nearly as abundant as the *Lima cardiiformis*, which it everywhere accompanies, but very frequently only in a crushed condition; it is shorter than the other and scarcely so convex.

(*d.*) LIMA BELLULA. Tab. III, fig. 9.

Testá ovato-obliquá, lævigatá; anticè convexá, abruptè truncatá posticè subcompressá, rotundatá; auriculis parvis inæqualibus; lunulá magná excavatá; superficie striis radiantibus tenuibus, nonnunquam obsoletis; striis anticis distinctis subdistantibus, posticis crebris evanescentibus.

Shell ovate, oblique, smooth; anterior side convex, abruptly truncated; posterior side rather compressed, its margin rounded; auricles small, unequal; lunule large and deeply excavated; the surface is ornamented with very delicate radiating striations, which anteriorly are distinct and rather distantly arranged, posteriorly they become much more closely arranged and are usually indistinct.

The general aspect of this species is shining and smooth, so that it is only upon close examination that it is discovered to have radiating striations; in young specimens these are always more or less visible, but in specimens of advanced growth only a few traces of the anterior striations remain. The concentric lines of growth are usually strongly marked and efface the striations.

With advance of growth some change is observable in the contour of the shell, it becomes more transverse and nearly orbicular.

Specimens from the Great Oolite of Lincolnshire do not attain to one third the linear dimensions of others from the Inferior Oolite of the Minchinhampton district, but it does not occur in the Great Oolite of Gloucestershire.

Localities. Barnack, Northamptonshire; Ponton, Lincolnshire; Culver Hill, on the western side of Minchinhampton Common, in the Inferior Oolite.

Pinna, *Linn.* 1758.

Gen. Char. Shell longitudinal, wedge shaped, acute anteriorly, truncated and gaping posteriorly; umbones straight, terminal and pointed; hinge lateral, linear, and without teeth; ligament marginal, linear, elongated, and partly internal; muscular impressions two, the anterior or byssal one minute, the posterior large. Substance of the shell thin, structure fibro-lamellar, composed of two layers, of which the exterior one is fibrous, the interior lamellar.

Pinna ampla, *Sow.*, sp. Tab. IV, fig. 14.

Mytilus amplus, *Sow.* Min. Con., t. 7, 1812.
Pinna ampla, *Goldfuss.* Pet., t. 129, f. 1.
— — *Deshayes.* Lam. An. s. Vert., 2de ed., vii, p. 68, 1836.
— — *Bronn.* Index Palæont., p. 977.

Testâ mytiliformi, mediocrè gibbosâ, costellatâ; costellis irregularibus, subplanis, undulatis, plurimis dichotomis aut confluentis et nodosis, striis transversis crebris et laminis incrementi impressis: umbonibus obtusis plerumque costellatis.

Shell triangular, moderately gibbose, longitudinally costated; costellæ numerous, very irregular, waved, for the most part bifurcated, confluent, knobbed and impressed with transverse striæ, which are very fine and closely arranged, and likewise by the laminæ of growth which are irregular. The hinge is straight, short, oblique, forming an angle of 45 degrees with the anterior border, the umbones are obtuse and usually costellated.

The radiating little ribs are but slightly elevated; they are tolerably distinct upon the anterior part of the shell, but posteriorly, where the folds of growth are larger, they become very irregular, confluent, or vanish altogether, a change exactly similar to that exhibited in the progress of growth of some recent *Pinnas;* in fact, well-preserved specimens of *Pinna ampla* are sometimes obtained, which are quite destitute of the longitudinal costellæ, and retain only the folds of growth. The substance of the test is thicker than is observed in recent shells of this genus.

It occurs rarely in the shelly beds of the Great Oolite, but more frequently in the Stonesfield slate of Gloucestershire.

Localities. Minchinhampton Common, in Great Oolite; Sevenhampton Common, in the Stonesfield slate; Wiltshire, in the Cornbrash.

In the Stonesfield slate of Stonesfield, Oxfordshire, and also in the Oolite of Mitford, Somersetshire.

PINNA CUNEATA, *Phillips*. Tab. VI, fig. 11.

PINNA CUNEATA, *Phillips*. Geol. Yorksh. i, t. 9, f. 17, 1835.

Testâ elongatâ, subcurvatâ, quadriquetrâ, latere antico convexo, postico compresso, margine acuto et excavato; superficie lineis undulatis radiantibus subnodosis aliis concentricis decussatis.

Shell elongated, somewhat curved, four sided, anterior portion convex, its margin convex, posterior portion compressed, its margin acute and excavated; the entire surface with undulating knotted radiating lines crossed by others concentrically disposed.

The concentric lines are very irregularly disposed, being much more closely arranged and indistinctly marked as the shell increased in size, at first they are not more numerous than the radiating lines. Length about $3\frac{1}{2}$ inches, basal diameter $2\frac{1}{4}$ inches, diameter through both the valves, 13 lines. In Gloucestershire, it occurs only in the upper division of the Inferior Oolite.

Localities. In the slaty Oolite of Easton and Collyweston, Northamptonshire, and in Lincolnshire; in the Cave Oolite of Yorkshire.

TRICHITES, *Lhwyd*, 1699.

TRICHITES, *Plot*, 1676; *Lhwyd*, 1699; *Guettard*, 1750; *Defrance*, 1828; *Pictet*, 1845; *Lycett*, 1850; *Deshayes*, 1851.
TESTA INCERTI GENERIS, *Woodward*, 1723.
PINNIGENE, *Deluc*, 1799.
CATILLUS, Sp., *Pusch*, 1836.
PINNA, Sp., *Deshayes*, 1835.
PINNIGENA, *D'Orbigny*, 1851.

Gen. Char. Shell of fibrous structure, thick, inequivalve, inequilateral, subquadrate, the valves anteriorly forming a prominent and somewhat pointed apex curved obliquely forwards. The left or larger valve convex and very thick, its apicial extremity hollowed internally, and forming with the corresponding portion of the other valve a funnel-like cavity, which is more or less open at its extremity; the right valve is thinner and flattened, or sometimes somewhat concave; the margins of the valves are very irregular and sinuated, but fit closely together all round, and there is always a large flexure upon the posterior side of the shell, forming a wide depression in that portion of the larger valve and a corresponding elevation in the smaller valve. The hinge border is very irregular and sinuated, it is nearly horizontal, lengthened, and internally without teeth, or any testaceous thickening. The interior side of the larger valve is much thicker than the other, its border is excavated beneath the apex, and is somewhat corrugated. The muscular impression is single, large, subcentral, and strongly impressed, its circumference has concentric step-like ridges. Ligament probably linear and subinternal, as in *Pinna*.

The individuals of a species vary much in the convexity of the valves and in the

character of the surface, so that species are not easily discriminated; the costæ, nodules, or other elevations which are occasionally present upon the surface, become indistinct or even vanish altogether; but their broad flexure upon the posterior side and their irregular sinuous hinge border are invariably conspicuous.

The structure of the test consists of closely-packed perpendicular fibres of a columnar aspect, which are traversed transversely by calcareous laminæ of extreme tenuity, parallel to each other, and sometimes of a colour different from the rest of the shell; they occur at very uncertain distances, appearing in the sections as so many fine lines, these thin laminæ give both to the external and internal surfaces of the valves a perfectly smooth appearance, and in some sections a dozen or more of them may be counted, they indicate successive additions of thickness to the test during the growth of the animal. The muscular impression exhibits the mode of growth in a very clear manner, the necessary addition of perpendicular fibres around its circumference producing a sudden elevation, or step like surface at the border of every successive zone of increase. The position of the muscular impression is rather posterior to the centre of the valves, or nearer to the posterior and superior border; there may also usually be observed upon the inner surface of the flat valve, at a little distance from the anterior border and parallel to it an elongated swelling, or rounded prominence, having exactly the contour of the outer border, and exhibiting the appearance of having formed the outer border at a former stage of growth, a feature precisely similar to that which is observed in certain oysters. The irregular swellings upon the surfaces of the valves do not coincide with the surface of the interior, sections of the thicker specimens often exhibit this circumstance in a very striking manner, and likewise a general irregularity and inequality in the thickness of the test; the inner surfaces of the valves, though smooth, are singularly uneven, and it is not uncommon to observe an occasional thickness in the test of seven or eight lines, terminate towards the posterior border in a considerable degree of tenuity and delicacy. It would seem that the transverse laminæ, whatever may have been their original structure, impeded fracture only to a very limited extent, for we find that in most cases the fracture is directly across all the laminæ, occasionally indeed the fracture has been arrested at the surface of one of the laminæ, and has followed the plane of its surface for some distance, an indication that its structure was lamellar. The fibrous structure then was very fragile, in the fossil state, fracture in the direction of the fibres takes place upon any slight concussion, however thick may be the test; and with the living shells the same circumstance seems to have obtained, for in the majority of instances, *Trichites* acquired its fossil state in the condition of fragments only, and these occur in such numbers, both in the Great and Inferior Oolite, as to indicate that this genus occupied a very prominent position amongst the marine fauna of the lower Oolitic epoch. The valves of *Trichites* (more especially the older and thicker specimens), are perforated, and sometimes literally honeycombed with little crypts of *Lithophagidæ*, in which, occasionally, the valves of the shells may be discovered; these perforations are a constant feature pertaining to *Trichites*, from whatever formation or bed

it is obtained, and a little search discloses the crypts in such extraordinary numbers, as to indicate that the *Lithophagidæ* then existed in a force which would not have been expected from the small number of instances in which their tests are preserved. In the shelly beds of the Great Oolite, the convex valve of *Trichites* is usually covered, and even loaded with small adherent oysters; but through these masses the perforations of the *Lithophagidæ* are found to have passed, a sufficient proof that the operations of the latter mollusks commenced posterior to the occupation of the adherent shells, and leading to an inference that the latter may have pertained to the living examples of *Trichites*. Our Great Oolite examples of the genus convey but a very inadequate idea of the magnitude which it sometimes attained; the upper division of the Inferior Oolite has disclosed sections of the valves upwards of two feet in length, and two inches in thickness. A shell imbued with such peculiar fragility, must have been unfitted to exist upon the bed of a littoral deposit exposed to the attritions and accidents to which such a position must have been incident, but in which, nevertheless, we find their remains; it seems more probable that they lived like the *Myadæ*, buried and defended in mud or sand, and that it was only by the denuding action of currents that their shells became exposed, and rolled with other fragmentary bodies.

In seeking for the generic forms allied to *Trichites*, we are reminded of the *Catilli*; the structure of the shell is alike in both genera, and the general figure is not very dissimilar, but the regularity of one contrasts with the irregularity of the other; the character of the surface more especially is distinct, the regular concentric folds of the *Catilli* have no affinity with the nodose and laminated surface of *Trichites*, nor can the recurved solid umbones and thick crenulated hinge plate of the former genus find any similitude with the *Pinna* like termination of *Trichites*. But if the character of the apex be allowed to resemble that portion of *Pinna*, we may search in vain for any other point of affinity with that genus; the structure of the shell in each differs materally; in *Pinna* it consists of two distinct layers, the external one of which is fibrous, but the internal is that of ordinary shell or nacreous, a structure tending to obviate the fragility which pertains to the fibrous structure of the outer layer, and very much resembling a method practised in the mechanical arts, for giving increased strength to thin layers, in substances whose fibres pass in different directions; by this contrivance, a shell very thin is made to possess a considerable degree of elasticity and strength; the other particulars, in which *Pinna* differs from *Trichites*, embrace every remaining generic character, as the equivalve form, its regularity, the gaping truncated posterior extremity, and lastly, the muscular impressions, of which *Pinna* has two. The preceding comparison with *Pinna* has been made in consequence of several authors, who confessedly had acquired only a very imperfect knowledge of *Trichites*, having classed the *Pinnigene* of Deluc, with *Pinna*, under the name of *Pinna Saussurei*.

It is now known that *Trichites* is abundant in the Oolitic rocks of England, and is found over extensive areas, but it is not confined to one of the Oolitic formations merely, as

there are other species which are nearly unknown to science; these circumstances, it is trusted, will sufficiently incite the industry of local collectors, and that ere long our knowledge of this obscure form will be augmented. On referring to the earliest notice of *Trichites*, we find that it dates even to the period when fossil shells were regarded as mere sports of nature, as the product of a supposed plastic power possessed by inorganic matter. Dr. Plot, in his 'Natural History of Oxfordshire, 1676,' applied the term *Trichites* to fragments of these shells, and figured a specimen in pl. 7, fig. 7; these he regarded merely as mineral curiosities. To Lhwyd is due the merit of having discovered their true position in the animal kingdom, and their distinctness from all known shells of Mollusca. He described in his 'Lithophylacii Britannici,' several species from the Coralline Oolite of Oxfordshire, a fact the more remarkable, when it is remembered that more than a century afterwards the majority of systematic writers omitted the genus altogether from their works, or confessed their imperfect acquaintance with it. In Woodward's 'Catalogue of British Fossils, 1723,' it seems to have been confounded with the *Catilli* of the cretaceous rocks, and is placed with the "Testæ incerti generis." Guettard recognised it in the Oolite rocks of Normandy, and mentioned it under the name of *Trichites*.

Deluc, in the great work of Saussure, 'Voyages dans les Alpes,' i, p. 192, made it a new genus, under the name of *Pinnigene*, and figured a species which has not been recognised in this country; he does not seem to have been aware of the identity of *Pinnigene* with the *Trichites* of Lhwyd. The article *Trichites*, in the 'Dictionnaire des Sciences Naturelles,' tom. lv, contributed by Defrance, contains a digest of all the information which had been acquired respecting this obscure form. Deshayes, in the 2d edition of Lamarck, 'Anim. s. Vert.,' tom. vii, p. 68, refers Deluc's species to *Pinna*, under the name of *Pinna Saussurei*, but states however that he had never seen a perfect specimen. Pusch, in his 'Polens Paleontologie, 1835,' page 45, offers some remarks upon fragments which he had detached from the rocks of the middle Oolite at Brzegi and Koritrice, but having no knowledge of the entire form, he refers the fragments to *Catillus*. Pictet, in his 'Traité Elémentaire de Palèontologie,' allows the generic value of *Trichites*, and reproduces the figures of Deluc reduced in size. Lastly, the reader is referred to a notice of this genus in the 'Annals and Magazine of Natural History for 1850,' p. 347, by one of the authors of this monograph.

TRICHITES NODOSUS, *Lycett*. Tab. III, fig. 11.

TRICHITES NODOSUS, *Lycett*. Ann. and Mag. of Nat. Hist., 1850, p. 347, t. 10.
— — *Bronn*. Leth. Geog., p. 221, t. 20, f. 1, 1851.

Testâ subquadratâ, convexâ, valvis valdè inæqualibus, valvâ sinistrâ convexâ, valvâ dextrâ concavâ; valvis varicibus subradiantibus irregularibus interdum dichotomis. Valvâ minorâ nodis nonnullis irregularibus. Apices valvarum attenuatæ et obliquæ.

Shell subquadrate, convex, the valves very unequal, the left valve being very convex or

gryphoid, the right valve somewhat concave; the valves ornamented with irregular varices, sometimes dichotomous, and imperfectly radiating. The smaller valve has a few unequal nodules upon the varices. Apices of the valves oblique and attenuated.

The thickness of the larger valve is moderate, the smaller valve is rather thin; specimens vary much in the convexity of the larger valve and in the varices, the latter being sometimes not distinguishable; the apices are much produced, attenuated, and curved forwards, more especially that of the larger valve. The almost constant manner in which the larger valve is loaded with adherent shells is a considerable obstacle to the determination of species, this, together with some variation in the figure of the valves, suggests doubts which are only to be removed by a comparison of numerous specimens.

Height, $5\frac{1}{2}$ inches; opposite diameter, $4\frac{1}{2}$ inches; diameter through both the valves, $2\frac{3}{4}$ inches.

Localities. Minchinhampton Common, where it is not unfrequent; Scar Hill, near Nailsworth, in the freestone of the Inferior Oolite, where it occurs very rarely.

In the Great Oolite of Comb Down, near Bath. (Museum of Practical Geology, presented by Mr. S. P. Pratt.)

Mytilus, *Linn.*, 1758.

Mytilus et Modiola, *Auct.*

Gen. Char. Shell longitudinal, oblique; umbones terminal or subterminal. Hinge lateral, linear, and without teeth, ligament marginal and somewhat internal, muscular impression elongated, club shaped, and placed somewhat laterally; anterior impression very small.

Mytilus Sowerbyanus, *D'Orb.* Tab. IV, fig. 1.

Mytilus Sowerbyanus, *D'Orb.* Prod. Pal. i, p. 282, 1850.
Modiola Sowerbyana, *Bronn.* Leth. Geog., p. 233, t. 15, f. 13, 1851.
— plicata, *Sow.* Min. Con., t. 248, f. 1, 1819.
— — *Zeiten.* Petref., t. 59, f. 7, 1835.
Mytilus plicatus, *Goldf.* Petref., p. 175, t. 130, f. 12, 1840.

Testâ elongatâ, soleniformi, anticè angustâ, obtusâ, posticè dilatatâ, angulo obliquo tenui bipartitâ, parte inferiore et anticâ lævigatâ, superiore et posticâ arcuatim plicatâ.

Shell elongated, pod-shaped, anterior part narrow and obtuse, posterior dilated, divided into two portions by a thin oblique angle, inferior and anterior part smooth, superior and posterior part with numerous curved folds.

The hinge margin is very much elongated and slightly curved, the inferior border is slightly concave and acute. The short costæ upon the superior border are parallel, oblique, and are impressed with numerous densely-arranged curved lines, which upon the lower portion of the shell are parallel with the inferior border.

Our Great Oolite specimens must be considered as a variety of this well-known shell, they are much attenuated at the anterior extremity, and unusually expanded and compressed at the posterior extremity. It occurs rarely in the Stonesfield Slate, and has not been observed in the shelly beds of the Great Oolite.

Localities. In the slaty beds at Minchinhampton Common; Stonesfield, Oxfordshire. Also in the Upper Marly deposits of the Great Oolite at Felmersham, Bedfordshire, and Blisworth, Northamptonshire.

M. D'Orbigny has changed the generally known name given to this species by Mr. Sowerby, as Gmelin had previously described a recent species under the name of *Mytilus plicatus.*

MYTILUS (MODIOLA) TENUISTRIATUS, *Munst.* Tab. IV, fig. 6.

MYTILUS TENUISTRIATUS, *Goldfuss.* Petref., t. 131, f. 5, 1840.
— — *Buckman.* Geol. Cheltenham, p. 69, t. 3, f. 3.

Testâ ovato-cordatâ, fornicato tenuissime concentricè striatâ, umbonibus terminalibus arcuatis, margine cardinali recto, brevissimo, dorso alto angusto, latere inferiore cordato, anticè subventricoso. (Goldfuss.)

Shell ovately cordate, short, very convex; umbones terminal acute and curved forwards, hinge border straight and short, dorsal surface very much elevated and narrow, inferior border sinuous, its anterior portion rather ventricose; concentric striations regular, fine, and closely arranged.

This is a short, obtuse shell, and the convexity of the valves is so considerable that the diameter through them, when in apposition, is nearly equal to their length; the striations are very delicate, and the test thin.

Locality. For this pretty species we are indebted to the kindness of Professor James Buckman, who collected it in a bed of yellow Clay at Sevenhampton, together with numerous other testaceous relics, which though numerous in species, are for the most part badly preserved. It is probable that this stratum, which can be traced for two miles and upwards, is a subordinate local deposit of the Great Oolite; at Sevenhampton, it is situated 22 feet above the Stonesfield Slate.

MYTILUS TUMIDUS. Tab. IV, fig. 5.

Testâ arcuatâ, inflatâ, striatâ concentricè rugosâ, margine cardinali curvato, margine inferiore concavo, umbonibus terminalibus obtusis, crassis.

Shell curved, inflated, with rugose concentric striæ, hinge margin curved, inferior margin arched or concave, umbones terminal, obtuse, and thick.

The dorsal surface is very elevated, narrow anteriorly, and more flattened posteriorly; the convexity of the valves is so considerable that the diameter through both is equal to

half the length of the shell, and is greater than the height; the general form is therefore narrow, very convex, and curved elliptically.

It occurs very rarely in the shelly beds of the Great Oolite.

Locality. Minchinhampton Common.

MYTILUS PULCHERRIMUS, *Roemer, var.* Tab. IV, fig. 12, 12 *a*.

MODIOLA PULCHERRIMA, *Roemer.* Verst., p. 34, t. 4, f. 14, 1836.
— — *Koch* and *Dunker.* Beitr. Oolith., t. 6, f. 7, 1837.
MYTILUS PULCHERRIMUS, *Goldfuss.* Petref., p. 177, t. 131, f. 9.

Testâ ovato-fornicatâ, umbonibus postmedianis retusis, margine cardinali recto, latere inferiore convexo, posticè subretuso, lineis radiantibus crebris supernè crassioribus concentricis decussatis.

Shell ovate, with an elevated dorsal ridge, umbones postmesial, extended backwards, hinge margin straight, inferior side convex, with radiating lines closely arranged upon the superior side, and decussated by very fine concentric lines, which form knots where they cross the longitudinal elevations.

The general figure is subquadrate, the height being equal to half the length, and the diameter through both valves is a little less than the height; the usual length is about four lines; the test is delicate and fragile.

Localities. All our specimens have been obtained in the bed of the soft Shelly Oolite, which at Minchinhampton Common underlies the planking. It is moderately rare. Ancliff, Wiltshire, (Mr. J. D. C. Sowerby's Collection.)

MYTILUS SOLENOIDES. Tab. IV, fig. 4.

Testâ prælongâ, ellipticâ, concentricè rugoso striatâ, anticè vix angustatâ, obtusâ, posticè paulum depressâ et dilatatâ; margine cardinali subrecto, margine inferiore in medio subsinuato.

Shell elongated, elliptical, gibbose, with rugose concentric striæ, anterior extremity rather narrow and obtuse, posterior extremity more depressed and dilated, hinge margin nearly straight, inferior margin sinuated.

The general aspect has a considerable resemblance to *Mytilus plicatus*, but it is much more gibbose, the diameter through both the valves being upwards of one third of the length, and it is destitute of the posterior plicæ, which distinguish that species; the concentric striæ are very prominent and irregular.

Modiola elongata, Koch and Dunker, which is probably *Modiola scalprum*, Sowerby, is also less gibbose.

Locality. The Slaty Oolite of Minchinhampton Common, rare.

MYTILUS SOLENOIDES, *var.* SUBRENIFORMIS. Tab. IV, fig. 11.

Testâ crassâ subdepressâ aut subreniformi, lævigatâ, umbonibus obliquis terminalibus, margine superiore arcuato, margine inferiore excavato aut subsinuato, plicis incrementi paucis irregularibus.

Shell thick, rather depressed, or kidney-shaped, smooth, umbones oblique, depressed, terminal, superior margin curved, inferior margin excavated or somewhat sinuated, folds of growth few and irregular.

The two extremities of the shell are nearly equally rounded and convex, an obscure and obtuse dorsal ridge extends in a curved direction from the umbones to the posterior and inferior extremity; the superior side of the shell has a considerable convexity, and the inferior or ventral side is compressed.

We have only obtained two specimens of this species, which occurred in the soft shelly Oolite which underlies the planking.

Height, 6 lines; length, 14 lines; diameter, through both the valves, 6 lines.

Locality. Minchinhampton Common.

MYTILUS FURCATUS, *Goldf., var.* BATHONICUS, *nob.* Tab. IV, fig. 9, 9 *a*.

MYTILUS FURCATUS, *Goldfuss.* Petref., t. 129, f. 6.
— — *Roemer.* Nordd. Ool., p. 33, t. 18, f. 38.
? MODIOLA ASPERA, *Phillips.* Geol. York., t. 11, f. 9.

Testâ ovato-acutâ, inflatâ, umbonibus acutis, margine cardinali subrecto obliquo, latere inferiore abrupto, costis crebris subpapillosis interdum dichotomis, lineis incrementi paucis magnis irregularibus.

Shell ovately acute, very convex, with terminal acute umbones; hinge border straight or rather oblique, anterior border steep and excavated; costæ numerous, closely arranged and indented with concentric striations, producing a papillary surface, the costæ are waved and occasionally dichotomous. The specimens rarely show the imbricated costæ.

The larger and indented costæ distinguish it from *M. asper*, Sow. It is not uncommon in the shelly beds of the Great Oolite, and varies in length from 3 to 16 lines.

Locality. Minchinhampton Common.

MYTILUS ASPER, *Sow.* Tab. IV, fig. 8.

MODIOLA ASPERA, *Sow.* Min. Con., t. 212, f. 3, 1818.

Testâ cuneatâ gibbosâ, arcuatâ longitudinaliter striatâ, lineis numerosis radiantibus furcatis, imbricatis; umbonibus incurvis subacutis, margine cardinali arcuato, posteriore subrecto.

An elongated arched gibbose and longitudinally striated shell, with rather small and curved beaks; striæ numerous, furcate, and minutely imbricated.

Mr. Sowerby remarks, "the small and nearly flat posterior lobe leaves the beaked end of this *Modiola* so small as to give it much of the contour of a *Mytilus*, the depth of the two valves together is greater than the width, and the length is twice the depth. The roughness of the striæ proceeds from minute elevated scales, that are most conspicuous near the margin of the shell, and are nearly obliterated towards the beaks."

It occurs somewhat rarely in the shelly beds of the Great Oolite, and likewise in the marl bed of the Inferior Oolite in the Cotswolds.

Localities. Forest Marble of Wiltshire; upper marly beds of Great Oolite, at Felmersham, Bedfordshire; Blisworth, Northamptonshire, &c.; Minchinhampton Common, in the Great Oolite; near Nailsworth and Cheltenham in the Inferior Oolite.

MYTILUS LONSDALEI. Tab. IV, fig. 3.

Testâ ovato-oblongâ, lævigatâ; anticè latâ, subdepressâ, posticè convexiore, angulo obliquo formante; umbonibus gracilibus incurvis, margine cardinali obliquo, curvato, margine inferiore subsinuato; laminis incrementi conformibus tenuibus.

Shell ovately oblong, smooth; anteriorly wide and depressed, posteriorly more convex, divided from the anterior portion by an oblique and obtuse angle, which passes from the umbo to the infero-posterior extremity; umbones slender, incurved; hinge border oblique and curved, inferior border slightly sinuated; the surface has numerous delicate irregular laminæ of growth.

The general figure has some resemblance to *Modiola subæquiplicatâ*, Roemer, Verst., tab. v, fig. 7, but the latter shell has greater convexity, the umbones are less attenuated and the oblique angle formed by the anterior depressed surface is less distinct. It has also some resemblance to *M. imbricata*, Sow., but is distinguished by the posterior portion being less expanded and the general form more elongated.

Length, 16 lines; height, 7 lines; diameter, through both the valves, 6 lines.

Localities. Sapperton railway tunnel, in the Great Oolite. In the Cornbrash of Wiltshire it is abundant.

MYTILUS COMPRESSUS, *Goldf.* Tab. IV, fig. 7.

MYTILUS COMPRESSUS, *Goldfuss.* Petref., t. 131, f. 11.
MODIOLA COMPRESSA, *Portlock.* Geol. Report, p. 122.

Testâ ovatâ subconvexâ, concentricè striatâ; umbonibus subanticis, compressis, margine cardinali recto, latere inferiore convexo-plano, posticè subcompresso prorsum rotundato.

Shell ovate, rather convex, concentrically striated; the umbones subterminal and compressed, hinge margin straight; inferior side moderately convex, posterior side rather compressed and rounded.

The anterior extremity is narrow and somewhat compressed, the posterior much

wider and more expanded, the concentric striæ are very numerous and distinct, the folds of growth are few and irregular.

Height, 7 lines; length, 11 lines; diameter, through both the valves, 4 lines.

Localities. It occurs rarely in the shelly beds of the Great Oolite, at Minchinhampton, and more frequently in the slaty or clay beds of the formation, as in the Bradford clay, near Cirencester, and the Stonesfield slate of Oxfordshire.

MYTILUS IMBRICATUS, *Sow.* Tab. IV, fig. 2.

MODIOLA IMBRICATA, *Sow.* Min. Con., t. 212, f. 1, 3, 1818.

Testâ ovato-reniformi convexâ concentricè striatâ, umbonibus subterminalibus arcuatis, dorso anticè angusto, posticè planiusculo, margine cardinali recto, parte anticâ lateris inferioris brevi ventricosâ.

Shell ovately reniform, convex, concentrically striated, umbones subterminal, curved, the dorsal convexity is narrow towards the anterior part, and more expanded posteriorly; the hinge border is straight, its length rather exceeding one third that of the entire shell. The concentric lines are very numerous, irregular, strongly marked and imbricated, those near to the posterior side being the most conspicuous.

Proportions of a medium sized specimen: Length, 21 lines; height, 10 lines; diameter, through both the valves, 9 lines. The largest specimens acquire dimensions one half greater.

This is by very much the most abundant *Mytilus* of the shelly beds of the Great Oolite, but the greater number of examples do not exceed 12 lines in length, and the valves are constantly disunited.

Localities. Great Oolite, at Minchinhampton; Stonesfield slate of the same district; Bradford Clay and Forest Marble, near Cirencester; also in the upper marly beds of the Great Oolite, in Northamptonshire, Bedfordshire, and Lincolnshire.

MYTILUS SUBLÆVIS, *Sow.* Tab. IV, fig. 19.

MYTILUS SUBLÆVIS, *Sow.* Min. Con., t. 439, f. 3, 1823.
— — *Bronn.* Leth. Geog., p. 236, t. 19, f. 14.
— — *Goldf.* Petref. ii, p. 170, t. 129, f. 3.
? MYTILUS JURENSIS, *Roemer.* Oolith., p. 89, t. 4, f. 10.
? — EDULIS, *Young* and *Bird.* Geol. Yorksh., t. 7, f. 10.

Testâ arcuato-cuneiformi, lævigatâ, umbonibus terminalibus, acutis, dorso anticè angusto et convexo, posticè expanso, margine superiore arcuato, inferiore concavo.

Shell curved and cuneiform, smooth, umbones terminal, acute, the back of the shell anteriorly narrow and convex, posteriorly expanded, superior margin curved, inferior margin concave with steep sides; lines of growth few, distant, regular, and strongly marked.

The hinge border is curved, and equal to half the entire length of the shell, the terminal umbones are remarkably acute, without any expansion upon the lower side. It is tolerably abundant in the shelly beds of the Great Oolite.

Dimensions of a medium sized specimen: Length, 23 lines; height, 12 lines; diameter, through both the valves, 9 lines.

Locality. The whole of the Minchinhampton district; Felmersham, Blisworth, &c.; in the marly deposits belonging to the upper portion of the Great Oolite.

MYTILUS BINFIELDI. Tab. IV, fig. 10.

Testâ ovatâ subarcuatâ concentricè striatâ, umbonibus obtusis, dorso fornicato, margine cardinali recto, latere inferiore abrupto antice convexo.

Shell ovate, superior side compressed, inferior side elevated, with terminal obtuse umbones, hinge margin rather oblique, the greatest convexity is about the middle of the valves, the lower margin is straight, and the general aspect of the shell is smooth.

It occurs rarely in the shelly beds of the Great Oolite.

Locality. Minchinhampton Common.

Named in compliment to Mr. W. R. Binfield, who has assiduously collected the fossils of the Oolite.

LITHODOMUS, *Cuvier*, 1817.

Gen. Char. Shell elongated, subcylindrical, anterior extremity rounded and convex, posterior extremity more attenuated, margins of the valves close all round; umbones anterior, terminal, pointed; hinge without teeth, ligament internal linear, and placed in a lengthened groove.

Lithodomus perforations are extremely common in the shelly beds of the Great Oolite; they are not, however, confined to the surface of any particular bed, but occur indifferently throughout a considerable thickness of shelly rock, and the more massive bivalves often exhibit their perforations, more especially *Trichites* and *Astarte subquadrata;* the number of these perforations proves that the *Lithodomi* existed in great profusion, and contrasts singularly with the paucity of the specimens preserved; we may infer from this fact, that a very qualified degree of dependence should be placed in the number preserved of certain thin and fragile bivalves, as representing the actual number of individuals which existed in the seas of the Oolitic period. The valves which occur in the shelly detritus are well preserved, others which remained in the hollow oval crypts are uniformly very tender and imperfect, they can scarcely be said to be fossilized; the crypts themselves are for the most part empty, or contain only a little hardened mud; when, however, the crypts are filled with calcareous spar, it is probable that the living animals themselves were entombed in the deposit.

LITHODOMUS INCLUSUS, *Phil.* Tab. IV, fig. 13, 13 *a*.

MODIOLA INCLUSA. Phil. Geol. York., i, t. 3, fig. 20, 1835.
— — *Deslongchamps.* Mém. Soc. Linn. de Normand, 1838, pl. 9, f. 39, 40.

Testâ parvâ, subelliptică, convexâ, umbonibus subanticis, margine postico compresso, producto et curvato, striis concentricis tenuissimis irregularibus, lineis incrementi paucis, distantibus.

Shell small, delicate, subelliptical, tumid, umbones anterior, nearly terminal, posterior margin compressed, produced, and curved; concentric striæ fine and irregular; lines of growth few, and distant.

This delicate little shell occurs in all the shelly beds of the Great Oolite, more especially in the beds of soft Oolite which underlies the planking, where the numerous cylindrical crypts sometimes contain it; the cavities themselves filled with calcareous spar, elongated and pyriform, are not uncommon; the general figure is much more tumid than is observed in the *Lithodomi* generally. The diameter through both the valves somewhat exceeds the height, and is equal to two thirds of the entire length, which latter rarely exceeds six lines.

Localities. Minchinhampton Common; Bisley Common; Ancliff, Wiltshire. It occurs also in the Coralline Oolite of Yorkshire (Phillips).

LITHODOMUS PARASITICUS, *Deslongchamps*, Sp. Tab. IV, fig. 15, 15 *a*.

MODIOLA PARASITICA, *Desl.* Mém. Soc. Linn. de Normand., 1838, t. 9, f. 44—46.
LITHODOMUS PARASITICUS, *D'Orbigny.* Prod. Paléont., p. 312, 1850.

Testâ parvâ, tenui, obliquâ, costis radiantibus magnis paucisque ornatâ, interstiis angustis, umbonibus terminalibus acutis.

Shell small, thin, oblique, lengthened, with terminal acute smooth umbones, the middle and posterior portions of the shell are ornamented with a few large radiating costæ, the interstitial spaces narrow and deeply depressed; the absence of decussating plications, and the acute apex readily distinguishes it from *Mytilus pulcherrimus*, the only contemporaneous allied species. It has occurred very rarely both in the shelly Great Oolite and Stonesfield Slate.

Localities. Minchinhampton; Langrune, Normandy.

Professor E. Deslongchamps records a curious fact connected with the occurrence of this species in Normandy: in a block of stone containing about twenty individuals, each of them occur within the valves of another species, the *Modiola* (*Lithodomus*) *inclusa*, which had previously effected their perforations in the limestone. The Rev. H. Jelly has described a somewhat analogous case, as occurring in the Bath Oolite, in which two or three individuals of a species of *Modiola* lie encased in the valves of a *Lithodomus*, that had perforated a coral.

Arca, *Linn.*, 1758.

Arca rudis, *Sow.* Tab. V, fig. 12.

Cucullæa rudis, *Sow.* Min. Con., t. 447, f. 4, 1824.

Testâ oblongâ, subcylindricâ, umbonibus magnis antemedianis approximatis, margine cardinali elongato, marginibus aliis arcuatis, costis radiantibus numerosis anticis et medianis acutis, posticis magnis irregularibus subdistantibus, nodosis, lineis concentricis decussatis.

Shell oblong, subcylindrical, umbones large, contiguous, and placed anterior to the middle of the valves, hinge border elongated, the other margins rounded; radiating costæ acute, elevated upon the anterior and middle portions of the valves, much larger, irregular, more distant and nodose upon the posterior side, decussated by numerous concentric lines.

The posterior side of the shell is rather compressed, and has four or five very prominent irregular knotted costæ; the concentric lines are very fine, and for the most part indistinct. It occurs rarely in the shelly beds of the formation.

Height, 6 lines; length, 12 lines; diameter through both the valves, 6 lines.

Localities. Minchinhampton and Bisley Commons; Ancliff, Wiltshire.

Arca pulchra, *Sow.* Tab. VI, fig. 6.

Arca pulchra, *Sow.* Min. Con., t. 473, f. 3, 1824.

Testâ ovato-oblongâ, convexâ, umbonibus antemedianis subdistantibus, margine cardinali elongato, margine infero parallelo, areâ angustâ, lateribus costalis radiantibus crebris subæqualibus, striis concentricis tenuissimis indentatis.

Shell ovately oblong, convex, umbones anterior, separated, hinge margin elongated, with the inferior margin of the valves parallel to it, area narrow; the sides of the valves are ornamented with densely arranged radiating little ribs, these are rather unequal in size, but radiate in every direction, and are indented by fine closely arranged concentric striations.

The example of this species figured in the 'Mineral Conchology,' represents the immature stage of growth in which the concentric striations are scarcely distinguishable, and the general form has not acquired the full degree of convexity. In the description of *Arca pulchra,* Mr. Sowerby states that it is "nearly twice as wide as long; the striæ are very uniform and close together; the valves are rather flat in the middle;" and further remarks—"Although there is hardly any appearance of a sinus in the margin, this is placed as an *Arca* because it has no transverse elongated teeth in the hinge, those nearest the extremities being longitudinal; it is, however, one of the links that unite the two genera."

Localities. The shelly beds of the Great Oolite throughout the Minchinhampton district; Ancliff, Wilts; Ponton, Lincolnshire.

ARCA KILVERTI. Tab. V, fig. 10.

Testâ oblongâ aut subrhomboidali, umbonibus medianis contiguis; lateribus compressis; basi arcuatâ; superficie bipartitâ sulco lato; costulis radiantibus (*circa* 50) *subnodosis, lineis concentricis crebris decussatis.*

Shell oblong or subrhomboidal, umbones moderately large, mesial, and contiguous; the sides of the shell compressed, the lower margin curved; the surface divided into two parts by a wide superficial sulcation; radiating lines or costæ (about 50) slightly nodose, and decussated by fine, closely arranged concentric lines.

Upon the sides of the shell the costæ are more widely separated, and the interstitial spaces sometimes disclose a smaller rib. It ranks as one of the more rare Great Oolite forms, the figure nearly agrees with *Arca bipartita*, Roemer, 'Nordd. Ool.,' tab. 14, fig. 12; but that species is destitute of the concentric lines.

Height, 3 lines; length, 6 lines.

Locality. Minchinhampton Common.

Named in compliment to Mr. Kilvert, of Bath.

ARCA TENUITEXTA. Tab. V, fig. 9.

Testâ parvâ, ovato-oblongâ, umbonibus obliquis antemedianis subdistantibus; marginibus rotundatis; dorso convexo, superficie mediano sulco lato impressâ; lineis radiantibus crebris minutis aliis concentricis decussatis.

Shell small, ovately oblong, umbones oblique, anterior to the middle of the valves, and separate; hinge margin of moderate length, its extremities rounded, base slightly sinuated by a wide but superficial sulcation which descends from the umbo; the entire surface is covered with radiating, closely arranged, depressed, very fine lines, crossed by others concentric and closely arranged.

The general figure has a considerable degree of convexity, and the hinge margin is very short; the radiating and concentric interstitial spaces are so minute that they resemble fine punctuations. It ranks as one of the smallest and most rare of the Great Oolite *Arcacea;* it is found in the planking and contemporaneous white stone of Bussage.

Localities. Minchinhampton and Bisley Commons.

ARCA PRATTII. Tab. V, fig. 3.

Testâ subrhomboideâ, umbonibus antemedianis contiguis, arcâ angustatâ; latere antico margine rotundo, latere postico producto, angulo obliquo declivi; costulis radiantibus

tenuissimis crebris, costulis posticis majoribus subnodosis; lineis incrementi paucis distantibus.

Shell subrhomboidal, umbones compressed, placed anterior to the middle of the valves, and contiguous; area narrow; anterior portion with the margin rounded, posterior side more lengthened, with an angle passing obliquely from the umbones to the infero-posterior extremity; radiating costæ very fine and closely arranged, the costæ posterior to the angle are larger and nodose; lines of growth few and distant.

The usual figure is compressed, and the posterior angle is acute, but there is much variation in the convexity of the valves. The *Arca funiculosa*, Goldfuss, tab. 121, fig. 13, has a general resemblance to it, but differs in having regular distinct concentric lines.

It is the most common *Arca* in the Great Oolite, and occurs throughout all the shelly beds.

Height, 8 lines; length, 15 lines; diameter through both the valves, 6 lines.

Localities. Minchinhampton, in the Great Oolite; Ancliff, Wiltshire. Leckhampton Hill near Cheltenham, in the shelly free stone of the Inferior Oolite; also in the Oolite of Ponton, Lincolnshire.

This species is dedicated to S. P. Pratt, Esq., F.R.S.

ARCA EUDESII. Tab. V, fig. 6, 6 *a*.

Testâ oblongâ, subcompressâ; umbonibus obliquis, acutis, antemedianis distantibus, areâ latâ; latere antico margine rotundo; latere postico producto carinato longitudinaliter plicato, plicis 3 *latis profundis; dorso costulis radiantibus crebris inæqualibus nodosis; striis concentricis frequenter obsoletis; basi rectâ.*

Shell oblong, rather compressed, umbones oblique, acute, anterior to the middle of the valves, and distant; area large; anterior side with the margin rounded, posterior side with an obtuse carina more produced, and having upon the surface posterior to the carina three large strongly-marked longitudinal plications; the dorsal surface has very fine radiating costæ densely arranged, knotted, and unequal; concentric striæ very faintly traced; inferior margin straight.

The less convex form will distinguish it from *Arca trisulcata*, Goldfuss, the figure is nearly that of his *Arca fracta*, but that shell is destitute of the posterior longitudinal plications, it is scarcely so wide as *Arca lata*, Dunker, and more compressed upon the dorsal surface; that species would likewise seem to want the large posterior folds. It occurs very rarely in the shelly beds of the Great Oolite.

Height, 7 lines; length 14 lines; diameter through both the valves, 7 lines.

Localities. Minchinhampton Common; Langrune, Normandy.

This species is dedicated to Professor Eudes Deslongchamps, of Caen, who has obligingly forwarded to us, for comparison, many interesting shells from the Great Oolite of Normandy.

ARCA ÆMULA, *Phil.* Tab. V, fig. 17.

ARCA ÆMULA, *Phil.* Geol. Yorksh., i, t. 3, f. 29, 1835.

Testâ subrhomboideâ, vel oblongâ, inæquilaterali, convexâ, umbonibus obliquis antemedianis distantibus; latere antico convexo, latere postico elongato, obtusi carinato et compresso; superficie sulco lato mediano; basi subrectâ; lineis radiantibus crebris minutis nodosis, plicis concentricis paucis interruptis: superficie posticâ excavatâ, plico unico obliquo mediano et sulcis duobus conformibus parallelis.

Shell subrhomboidal or oblong, inequilateral, convex, umbones oblique, placed anterior to the middle of the valves and separated by a moderately wide area; anterior side convex, posterior side elongated, obtusely carinated and compressed; the dorsal surface with a wide and slightly oblique depression which is not always distinct; basal margin straight; radiating lines closely arranged, fine, minute, and knotted, interrupted by a few concentric plications; the surface posterior to the obtuse carina is concave, has a mesial oblique plication which is bounded upon each side by a sulcation.

The greater number of examples have not preserved the lines which ornament the surface, but the posterior plications are always distinctly shown. In the Great Oolite of Minchinhampton, the species occurs in a dwarfed or rather in an immature form, which would scarcely be identified, but for the aid of specimens from other localities; it occurs well preserved in the shelly roe stone of Leckhampton Hill, and likewise in the Ponton Oolite, at both of which places it attains its full dimensions.

Localities. Minchinhampton and Bisley Commons. Ponton, Lincolnshire.

ARCA ÆMULA, *Phil.* var. TRANSVERSA. Tab. V, fig. 8.

A shell which we consider to be only a variety of *A. æmula* requires a separate notice, it is more elongated and subcylindrical, the mesial or oblique depression upon the dorsal surface is usually distinctly marked, and the shell never acquires the dimensions of the typical form, the length of the largest specimens not exceeding 10 lines.

The more mesial position of the umbones will serve to distinguish this shell from young examples of *Macrodon Hirsonensis,* to which in other respects it has a considerable resemblance; it is more elongated and cylindrical than any other of the contemporaneous *Arcacea.*

It occurs not uncommonly throughout the shelly beds of the Great Oolite, but the delicate features of its surface are seldom well preserved.

Localities. Minchinhampton and Bisley Commons.

ARCA RUGOSA? var. of ARCA PRATTII. Tab. V, fig. 2.

Testâ subrhomboideâ, convexâ, anticè rotundâ, posticè compressâ, angulo obliquo acuto; umbonibus depressis approximatis, antemedianis lineis radiantibus crebris undulatis subnodosis et imbricatis; plicis concentricis rugis, irregularibus subundulatis; basi subsinuatâ.

Shell subrhomboidal, convex, anterior side rounded, posterior side much compressed,

with an oblique sloping acute angle; umbones depressed, approximate, placed anterior to the middle of the valves, radiating costæ closely arranged undulated, slightly nodulated and imbricated; concentric folds numerous, rugose irregular and somewhat undulated; base sinuated.

This species is exceedingly irregular both in its general figure and convexity, the portion of the shell posterior to the carina is excavated and compressed, the lines upon its surface are much knotted; *Arca Prattii* approximates to it but is less convex, and in that species the lines are not nodose, neither has it the concentric undulating plications and sinuous base which distinguishes the *Arca rugosa*. It occurs somewhat rarely in the shelly beds of the Great Oolite.

Localities. Minchinhampton and Bisley Commons.

ARCA MINUTA, *Sow.* Tab. V, fig. 11 *a*; Tab. VI, fig. 19.

CUCULLÆA MINUTA, *Sow.* Min. Con., t. 447, f. 3, 1824.

Testâ parvâ trapeziformi, convexâ, umbonibus acutis submedianis, subdistantibus, areâ magnâ lævigatâ obliquâ; lateribus striis crebris radiantibus plicis incrementi interruptis.

Shell small trapeziform, convex, with acute and rather distant umbones, area large, smooth, sloping obliquely, the sides of the valves with densely arranged radiating striations, broken by the concentric plications of growth.

The figure of this little shell varies considerably in the size of the area, and in the general convexity, the posterior angle is strongly marked, rather acute and slightly concave; the striations are only visible under a magnifier; from two to ten lines appear to be the amount of variation in length. It is not common, and is usually badly preserved, its range is throughout the Great Oolite and Bradford clay of Gloucestershire.

Localities. Minchinhampton; Ancliff, Wiltshire; Langrune, Normandy.

Sub-Genus—MACRODON, *Lycett.*

MACRODON, *H. E. Strickland* and *J. Buckman.* Geol. of Chelt., 1845, p. 98.

Testâ subrhomboideâ, umbonibus anticis subremotis, areâ cardinali modicè latâ lævigatâ, margine cardinali recto valde elongato; latere antico convexo crasso, latere postico compressiusculo, tenui et subtruncato; margine inferiori corrugato, sinuato et hiante. Cardo linearis, dentibus (5—7), *anticis, angustis parallelis et obliquis; dentibus posticis plerumque duobus, angustis, longitudinaliter elongatis ad extremitatem posticam testæ productis. Impressio muscularis, anticus elevatus* (*ut in Cucullæa instructa,*) *posticus obsoletus.*

Shell subrhomboidal, umbones anterior, rather distant, cardinal area moderately wide, smooth, hinge line straight, and much elongated; anterior side rounded and thick, posterior side rather compressed, somewhat truncated and thinner, inferior margin corrugated in its middle part, sinuated and gaping. Hinge linear, teeth (5—7), situated anteriorly, narrow, parallel, and oblique; posterior teeth usually two, narrow, elongated longitudinally

extending nearly to the posterior extremity of the hinge line. Of the muscular impressions the anterior one is elevated upon a raised internal projecting ledge, as in *Cucullæa*, the posterior impression is indistinct. The general figure is that of *Byssoarca*, the umbones which are rather small, are placed near to the anterior extremity of a very lengthened hinge line, the corrugation in the ventral border and hiatus are strong points of resemblance to that genus. The dental characters present an approach to those of *Cucullæa*, but in lieu of diverging from the central or subumbonal portion of the hinge line, as in that genus, they are all turned in one direction inclining posteriorly. Another external feature should be noticed, which it possesses in common with some other of the *Arcacea*, viz.: there is a depression upon the back of the shell, extending obliquely from the umbo to the middle of the lower border. In generic value, this form will take rank with *Cucullæa* and *Byssoarca*, but whether the two latter should be regarded, of generic or only of subgeneric value, as considered by some authors, is a subject which we will not discuss; Palæontologists, however, will perceive the convenience of separating the present form from others of the *Arcacea*.

Macrodon Hirsonensis, *D'Archiac*, Sp. Tab. V, fig. 1, 1*a*, *b*, *c*.

Cucullæa elongata. Phil. Geol. York., i, t. 11, f. 43, 1835.
— — *Goldfuss*. Pet., t. 123, f. 9, 1840.
— Hirsonensis, *D'Archiac*. Mém. Soc. Géol. Fr., t. v, t. 27, f. 5, 1843.

Testâ in ætate juniori costatâ, costis radiantibus, regularibus, et imbricatis, ætate progrediente costis plerumque obsoletis, cum laminis incrementi magnis, paucis et rugis.

Shell in the young state costated; costæ radiating, elevated, regular and imbricated; with increase of growth the costæ gradually disappeared, and the surface was rendered rugose by large folds or laminæ of growth, which are usually few and distant; they become corrugated near to the hiatus in the lower border, as in *Byssoarca*.

The aspect of this shell changed so much during the progress of growth, that without a regular series for comparison, the larger and smaller specimens would probably be separated into distinct species; the figure given in the 'Geology of Yorkshire,' Pt. 1, t. 11, fig. 43, accurately represents the shell in its young state; the costæ are then sharply defined, perfectly regular, and it has not acquired the laminæ of growth which subsequently disarranged the regularity and continuity of the costæ; the figure of Goldfuss, t. 12, fig. 9, is rather more elongated than is usual, it is of middle size, and the costæ are still visible; the figure of D'Archiac, t. 27, fig. 5, though beneath the middle size, represents the stage of more advanced growth, in which the costæ are obliterated, and the lower border becomes corrugated. Sometimes, however, traces of the costæ are visible even upon shells of the largest size, and on the other hand, small shells may be found smooth. The cast figured under the name of *Macrodon rugosus*, by Professor Buckman, in the 'Geology of Cheltenham,' plate 5, fig. 5, appears to represent another species which has a few distant and strongly-marked radiating costæ.

Localities. It occurs abundantly in the Minchinhampton district, but is chiefly found in the planking of Minchinhampton Common; it occurs likewise more rarely in the Inferior Oolite of the same district. Ponton, Lincolnshire.

Height of the largest example, $2\frac{1}{2}$ inches; length of the hinge line, 5 inches.

Sub-Genus—CUCULLÆA, *Lam.*, 1801.

Gen. Char. Shell inequilateral ventricose; umbones large, distant, separated by a ligamental area. The posterior surface with an oblique angle more or less prominent; the margins of the valves close all round. Hinge linear straight, teeth radiating obliquely from beneath the umbones. Muscular impressions two, of which the anterior one is supported by an elevated plate or ledge, projecting from the side of the shell; the posterior impression is rounded and faintly marked.

CUCULLÆA CONCINNA, *Phil.* Tab. V, fig. 7.

CUCULLÆA CONCINNA, *Goldfuss.* Petref., t. 123, f. 6? 1840.
— — *Phil.* Geol. York., i, t. 5, f. 9, 1835.
? CUCULLÆA SUBLÆVIGATA, *Zieten.* Wurtt., p. 75, t. 56, f. 3, 1834.

Testâ ovato-rhomboideâ, convexâ, umbonibus antemedianis magnis depressis approximatis; latere antico brevi margine rotundo; latere postico acute-carinato obliquo declivi; superficie striis concentricis regularibus crebris; lateribus costis radiantibus paucis et prominentibus.

Shell ovately rhomboidal, convex, umbones anterior to the middle of the valves, large, depressed, and nearly touching each other; anterior side short, its margin rounded; posterior side with an acute carina sloping obliquely; the surface has closely arranged, regular and very fine concentric striations; the sides of the shell have a few radiating prominent costæ, those upon the anterior side are four, elevated and distant.

Our specimens agree with the figure of Phillips, but differ somewhat from that of Goldfuss, which has fine radiating lines; it is probable, therefore, that the latter is a distinct species.

It occurs not uncommonly in the shelly beds of the Great Oolite.

Localities. Minchinhampton and Bisley Commons.

CUCULLÆA GOLDFUSSI, *Roemer.* Tab. V, fig. 4, 4*a*.

CUCULLÆA GOLDFUSSII, *Roemer*, 1836. Nordd. Ool., p. 104, t. 6, f. 18.

Testâ trapeziformi convexâ, concentricè subrugosâ, anticè rotundatâ, angustatâ, posterius angulo rotundo cordato-compressâ margine postico oblique truncato; umbonibus crassis prominulis incurvis, areâ lanceolatâ 5—6 *striatâ.* (*Roemer*).

Shell trapeziform convex, the surface with irregular concentric rugose plications, anterior side short, convex, its margin rounded, posterior side with an oblique obtuse angle, the side posterior to the angle compressed and truncated; umbones large, incurved, and almost touching each other; area lanceolate, of moderate size, with 5 or 6 striæ.

This species has some resemblance to *Cucullæa oblonga*, Phillips, but it is less elongated, the umbones are more compressed, and it is destitute of all radiating lines; the more oblique form, compressed umbones, and longer posterior side, will distinguish it from *Cucullæa cucullata*, when the surface markings of that species are not distinguishable.

Height, 16 lines; length, 21 lines; diameter through both the valves, 14 lines.

Localities. Minchinhampton and Bisley Commons, where it occurs in all the shelly beds.

CUCULLÆA CUCULLATA, *Goldfuss*. Tab. V, fig. 5.

CUCULLÆA CUCULLATA, *Goldfuss*. Petref., p. 148, t. 123, f. 7, 1840.

Testâ ovato-rhomboideâ, ventricosâ, umbonibus antemedianis approximatis, latere postico compresso-declivi, concavo, carinato lævi; lineis concentricis confertis et radiantibus subtillissimis. (Goldfuss.)

Shell ovately rhomboidal, ventricose, umbones placed anterior to the middle of the shell, oblique, and somewhat separated; posterior side with an oblique obtuse carina, posterior to which is a flattened or slightly concave surface; the inferior margin is curved; the lines both radiating and concentric are closely arranged, very fine, but irregular and unequal, the part posterior to the carina or angle being destitute of lines; the plications of growth are faintly marked, few, and distant.

The finely reticulated surface is usually most distinct in young specimens, those of more advanced growth being nearly smooth. It occurs throughout the shelly beds of the Great Oolite, but is not abundant. It likewise occurs in the middle division of the Inferior Oolite at Leckhampton, and near to Nailsworth in Gloucestershire.

Locality. Minchinhampton Common.

NUCULA, *Lam.*, 1801.

Gen. Char. Shell transverse, inequilateral, ovately oblong; hinge linear, separated in the middle by a fossa or oblique channel; teeth numerous, elevated, narrow, or frequently comb-like; umbones contiguous, curved posteriorly; ligament partly internal, inserted in the central fossa or canal.

NUCULA VARIABILIS, *Sow.* Tab. V, fig. 13, 13*a*.

NUCULA VARIABILIS, *Sow.* Min. Con., t. 475, f. 2, 1824.
— — Phil. Geol. York., vol. i, t. 9, f. 11, 1835.
NUCULA SUBGLOBOSA, *Roemer*. Verst. Oolith., t. 6, f. 7, 1836.

Testâ parvâ, læviusculâ, ovatâ, convexâ, obliquâ, umbonibus anticis, latere antico brevissimo, latere postico, oblique declivi, basi ellipticâ curvatâ, lineis concentricis irregularibus tenuissimis.

Shell small, smooth, ovate, convex, oblique, umbones anterior, anterior side very short, posterior side lengthened, its border obliquely sloping, base curved elliptically, lines concentric, irregular, and very fine.

This small shell is common throughout the shelly beds of the Minchinhampton district, where its figure is much less variable than in the specimens from Ancliff, which are figured in the 'Mineral Conchology,' so that it is not easily mistaken for any other contemporaneous species.

Localities. Ancliff and Minchinhampton.

NUCULA WALTONI, Tab. V, fig. 14.

Testâ parvâ ovatâ subcompressâ, umbonibus acuminatis, anticis, latere antico rotundo, postico elongato et subrostrato.

Shell small, ovate, rather compressed, umbones acute and anterior; anterior side short and rounded, posterior side elongated and somewhat rostrated.

The figure has some resemblance to *N. acuminata*, but the anterior side is much more produced, the posterior extremity more pointed; there is a kind of obtuse ridge, extending posteriorly from the umbo to the inferior and posterior extremity, and the junctions of the valves posteriorly are compressed, and the surface is very smooth. It is very common in the Clays of the Fullers-earth and likewise in the Bradford Clay, having the valves in apposition; in the shelly beds of the Great Oolite it occurs very rarely, and the valves are disunited.

Localities. The Cotswold Hills, at various localities in the Fullers-earth; the Tetbury Road Railway Station, in the Bradford Clay; Minchinhampton Common, in the Great Oolite.

This species is dedicated to that indefatigable collector, Mr. Walton of Bath.

LEDA, *Schumacher*, 1817.

NUCULA (pars), *Lam.*
LEMBULUS, *Risso*, 1826.
DACROMYA. *Agass.*, 1840.

Gen. Char. Shell inequilateral, umbones small, contiguous, anterior side convex, its margin rounded; posterior side attenuated, posterior slope lengthened, and excavated; teeth numerous parallel, separated in the middle by a fossa, structure of the test fibro-lamellar.

LEDA MUCRONATA, *Sow.*, Sp. Tab. VI, fig. 7.

NUCULA MUCRONATA, *Sow.* Min. Con., t. 476, f. 4, 1824.

Testâ parvâ subrhomboidali, rotundatâ, convexâ concentricè sulcatâ, posticè mucronatâ.

Shell subrhomboidal, rounded, convex, concentrically sulcated, posteriorly mucronated.

Two thirds as long as wide, very minute; the posterior side is drawn out in the form of a flattened spine, and is distinguished from the other portion of the shell by being flatter. (Sowerby.)

The figure of this shell is copied from the one given in the 'Mineral Conchology.'

Locality. Ancliff, Wiltshire.

LEDA LACHRYMA, *Sow.*, Sp. Tab. V, fig. 15, 15*a*.

NUCULA LACHRYMA, *Sow.* Min. Con., t. 476, f. 3, 1824.
— — Phil. Geol. York., i, t. 11, f. 14, 1835.
— — *Goldfuss.* Petref., t. 125, f. 10, 1840.
NUCULA CAUDATA, *Köch* and *Dunker.* Beit. Nord. Ool., p. 31, t. 2, f. 7, 1837.
? LEDA ACASTA, *D'Orb.* Prodrom. Paléont., i, p. 275, 1850.

Testâ ovato-subtriquetrâ ventricosâ, anticè inflatâ, posticè elongatâ attenuatâ, umbonibus antemedianis, lunulâ declivi ellipticâ, marginatâ, angulo cardinali obtuso; lateribus striis concentricis remotiusculis interdum obsoletis.

Shell ovately subtriquetral, ventricose, anterior side inflated, posterior side lengthened and attenuated, umbones anterior to the middle of the shell, lunule elliptical, sloping obliquely and marginated, the cardinal angle obtuse; the sides of the shell with regular concentric striations, rather remote, and faintly impressed, sometimes undistinguishable.

The few specimens which have been obtained agree with the figure in the 'Mineral Conchology,' rather than with that of Goldfuss, which is more produced posteriorly; the apparent absence of striations in the specimen figured by Sowerby has induced D'Orbigny to regard the striated figure of Goldfuss as distinct, but whoever has examined the half-obliterated striations of the Great Oolite specimens will be convinced of the fallacy of such a distinction. The figure 15*a* represents the smooth variety from Ancliff, which has been kindly lent to us for comparison by Mr. J. D. C. Sowerby.

Localities. Minchinhampton and Bisley Commons; Ancliff; it is rare.

LIMOPSIS, *Schacci*, 1827.

TRIGONOCÆLIA, *Nyst*, 1834.
PECTUNCULINA, *D'Orbigny*, 1850.

Gen. Char. Shell smooth, transverse, ovately oblong or subquadrate, umbones mesial depressed, contiguous; hinge curved, teeth raised, numerous, minute, placed in a parallel series, which is separated in its middle portion by a triangular depression. Ligament

nearly internal, placed in the trigonal fossa beneath the umbones, margins of the valves entire.

The smooth valves, mesial cardinal fossa, subquadrate form, and entire margins distinguish it from *Pectunculus*. The general character of the hinge presents an approximation to *Limea*, Goldfuss, both in the curvature of the series and form of the teeth; the latter genus may in fact be regarded as a representative of *Limopsis* amongst the *Limæ*. In *Nucula* the series of teeth form an angle, they are narrow and raised like a comb.

LIMOPSIS OOLITICUS, *D'Archiac*, Sp. Tab. V, fig. 16, 16*a*.

PECTUNCULUS OOLITICUS, *D'Archiac*. Mém. Soc. Geol. Fr., t. v, t. 27, f. 6, 1843.
? — OBLONGUS, *Sow*. Min. Con., t. 472, f. 6, 1824.
? — MINIMUS, *Sow*. Ibid., t. 472, f. 5.

Testâ lævigatâ oblongâ, convexo-planâ, subcompressâ inæquilateratâ, umbonibus prominulis, obliquis, lateribus oblique truncatis.

Shell smooth, oblong, more or less transverse, convex but somewhat flattened, inæquilateral, umbones prominent, oblique, the sides obliquely truncated, the lower margin lengthened and curved.

This species, which is very abundant, occurs under several varieties of aspect; the hinge line may be nearly straight and angular, or rounded; the figure may differ much in the degree of convexity, and in the length transversely; all the specimens are larger than the Ancliff shells which were figured in the 'Mineral Conchology' under the specific names *P. minimus* and *oblongus*, but which, nevertheless, we are disposed to regard as only varieties of the present species, and to these we might add another variety, which together with a short superior or hinge border, has several irregular folds upon the surface, giving it a rugose aspect. Owing to the great abundance of the species, we are at any time enabled to compare these varying forms, the test being thick, always well preserved, and never compressed. It occurs indifferently in all the shelly beds, and is one of the most common shells of the formation.

The *Limopsis Dammariensis* of Buvignier, 'Geol. de la Meuse,' p. 20, pl. 16, f. 26—29, has some resemblance to our species, but has greater convexity and less angularity of figure.

Localities. The entire formation in the Minchinhampton district; Ancliff, Wiltshire. Eparcy, Langrune, France.

TRIGONIA, *Bruguière*, 1791.

TRIGONIA, *Lam.*, 1804. *Park*, 1811. *Sow.*, 1815. *D'Orbigny*, 1850.
HIPPOCEPHALOIDES (NUCLEUS), *Plot.*, 1676.
LYRIODON, *Bronn*, 1836. LYRODON, *Goldfuss*, 1838.

Gen. Char. Subtrigonal, rounded anteriorly, truncated posteriorly with an oblique

flattened, or excavated area, which extends posteriorly from the umbo to the infero-posterior extremity, and is separated from the dorsal surface by a ridge or angle, and by a similar division from a small lanceolate space upon the other side, the anterior part of which supports the ligament; umbones recurved, contiguous, usually angulated; the dorsal surface is ornamented with longitudinal or concentric rows of costæ or tubercles. The hinge has four oblong compressed diverging teeth in one valve, the sides of which are grooved transversely, and two similar teeth in the other valve; ligament external, muscular impressions two in each valve, elliptical, and deeply impressed.

In the descriptions of species, we use the term *marginal carina* to indicate the ridge which bounds the area from the other surface of the shell; *inner carina*, the ridge which separates the area from the lanceolate space; the *median carina* is a ridge or line of tubercles which passes longitudinally along the middle of the area.

TRIGONIA SUBGLOBOSA. Tab. V, fig. 21.

Testâ suborbiculari, convexâ, umbonibus prominulis recurvatis; margine anteriore et inferiore rotundato, margine posteriore brevi et concavo; areâ brevi, latâ transversè striatâ, carinis tribus ornatis, carinis tuberculosis, carina marginali tuberculis majoribus; costis numerosis per series angulatis dispositis, posticè magnis et tuberculatis, anticè lævigatis crebris interdum obsoletis.

Shell subglobose, umbones prominent and recurved, the anterior and inferior margins rounded, the posterior margin short and somewhat concave; area short and wide, striated transversely, and ornamented with three tuberculated carinæ, of which the marginal carina has the larger tubercles; the space between the inner carinæ is smooth and short; the other portion of the shell has numerous closely-arranged oblique tuberculated costæ which form a series of angles upon the middle of the shell, the angles being usually greater than right angles. The anterior portions of the costæ pass obliquely downwards to meet the posterior portions, they are smooth, usually undivided, and towards the lower part of the shell become nearly obsolete; their posterior portions are large, forming irregular varices, which are very prominent. It is nearly allied to *Trigonia Goldfussii* in the character of its surface, the chief distinction consisting in the fewer costæ and less acute angle of the latter species; but the figure of the two species is very different. *T. Goldfussii* is much more flattened and less elongated posteriorly, the umbones are not recurved, the figure of the area altogether is more lengthened and straight, and it likewise attains to a larger size than *T. subglobosa*.

Our species occurs rarely both in the shelly beds of the Great Oolite and in the upper part of the middle division in the Inferior Oolite.

Localities. Minchinhampton Common, in the Great Oolite; Nailsworth, or Scar Hill, in the Inferior Oolite.

TRIGONIA GOLDFUSSII, *Agass.* Tab. V, fig. 18, 18*a*.

LYRODON LITTERATUM, *Goldfuss.* Petref., t. 136, f. 5, 1840.
TRIGONIA GOLDFUSSI, *Agaz.* Mém. sur les Trigonees, p. 35.
? — CUSPIDATA, *Sow.* Min. Con., t. 507, f. 4, 5, (junior.)

Testâ plano-convexâ, ovato-trigonâ, anticè et infernè rotundatâ, posticè truncatâ; tuberculis per series undulatas dispositis, ad carinam marginalem crassissimis; carinâ marginali tuberculis ornatâ; areâ cardinali transversim striatâ; tuberculis nonnullis in carinâ internâ. (Agassiz, pro parte.)

Shell with a moderate convexity, ovately trigonal, the anterior and inferior borders rounded, the posterior border truncated; umbones not prominent, nearly straight, costæ few, tuberculated, disposed in a series of rows which anteriorly are slightly curved, passing obliquely downwards, posteriorly the costæ are larger, and are curved upwards at a considerable angle; the area is flattened, transversely striated in the young state, but nearly smooth in the adult; the inner carina is slightly tuberculated, and the tubercles upon the marginal carina are more distinct.

The series of costæ posteriorly, which at first are tuberculated and moderately curved, afterwards gradually become large, irregular compressed varices, which are directed nearly perpendicularly downwards, and form a considerable angle at their junction with the posterior portions of the costæ. The inner carina is small and indistinctly tuberculated; the marginal carina is much larger, but has likewise indistinct tubercles, which disappear altogether in the adult state of growth; the area is divided into two parts by a slight longitudinal furrow.

The examples of this species are moderately numerous and of every stage of growth, so that ample materials are afforded for comparison. The surface markings underwent a continuous change throughout the life of the *Mollusk;* in the earliest condition, when the length is only 6 or 7 lines, the surface has a few regular curved and smooth costæ, which form an angle or prominence as they pass over the marginal border (or position of the carina), to the area which they cross, forming so many large plications; when about seven costæ have been perfected, those which succeed begin to have their posterior extremities more curved and indented to form tubercles, the plications upon the area have then degenerated into striations; ultimately these latter become indistinct, and the portion of the area last formed is nearly smooth; the posterior extremities of the costæ gradually become large varices, which are directed nearly perpendicularly downwards, and are imperfectly united to the anterior portions. The minute shell from Ancliff, figured in the 'Mineral Conchology' under the name of *Trigonia cuspidata,* Sow., is probably the present species in its earliest stage of growth.

It will also be perceived, that the young shell very nearly resembles the same stage of *Trigonia Moretoni* the only distinction residing in the more prominent costæ of *T. Goldfussii.* The Great Oolite shells never attain to the magnitude of those figured by

Goldfuss, and the small example figured by him, tab. 136, fig. 5*a*, appears to be another species altogether unlike the young examples of our shell. *Trigonia litterata* of Phillips, 'Geol. Yorksh.,' i, tab. xiv, fig. 11, from the *Lias* of Robin Hood's Bay, is likewise a distinct species, and having the priority, that specific name must be retained for it. *Trigonia Goldfussii*, and more especially young specimens, occur not unfrequently in the coarse bed of planking forming part of the shelly beds of the formation. *Trigonia undulata* from Fromberg, of which M. Agassiz has given two very different figures, would appear to be nearly allied to our species, more especially the shell figured by him, (Etudes Mol. Trigonées, tab. vi, fig. 1,) which exhibits small tubercles upon the carinæ.

Locality. Minchinhampton Common.

TRIGONIA MORETONI. Tab. V, fig. 19, 19*a*.

? TRIGONIA CONJUNGENS, *Phillips*. Geol. Yorkshire, i, p. 122.

Testâ ovato-trigonâ, plano-convexâ, umbonibus obtusis recurvis, areâ angustâ, transversim plicatâ; plicis magnis irregularibus; carinâ marginali et internâ depressis irregulariter subnodulosis; costis per series numerosis (ætate juniori arcuatis, adulto subangulatis,) et tuberculatis, tuberculis posticis magnis crebris confusè dispositis.

Shell ovately trigonal, rather depressed, umbones obtuse, recurved, anterior border rounded, posterior border lengthened and slightly excavated; area narrow, transversely plicated, plications large and irregular; marginal and inner carinæ depressed, rather obscure, (more especially in adult specimens,) irregularly undulated; costæ disposed in a numerous series (about 16), which in the young state are regularly curved, but subsequently become somewhat angulated; they are tuberculated, the posterior tubercles being the larger, closely arranged and much confused or irregular.

In the earliest stage of growth the aspect is so dissimilar that it requires a separate notice, the shell is rather compressed, the costæ are prominent, regular, and smooth, the plications upon the area appearing like continuations of the costæ, which they nearly equal in size, and the oblique divisional line upon the area which replaces the median carina is perceptible.

It is only when five or six costæ have been perfected, that they become indented, the indentations becoming more strongly marked with succeeding costæ, and at length forming distinctly rounded tubercles; during a series of five or upwards, the tuberculated costæ continue to have a regular graceful curvature, but subsequently they become irregular and confluent; posteriorly the tubercles are large, and the costæ are at that part usually bent upwards at a considerable angle. Thus in the adult stage of growth, the surface is always irregular and varies in every individual, even more than is usual in the tuberculated *Trigoniæ*. It would seem to be more nearly allied to *T. impressa* than to any other British species, but it is twice or thrice as large, has greater convexity, the apex is more obtuse, the area has much larger and more distantly arranged plications, neither has

it the distinct and regularly tuberculated marginal carina of that species; the arrangement of the rows of costæ is similar, but the tubercles are larger, and the adult condition more confusedly disposed in our shell.

It occurs in the shelly beds of the Great Oolite, in which small specimens are abundant, but adult forms are comparatively rare. The species is respectfully dedicated to Lord Moreton, who has assiduously cultivated geological science.

Localities. The Minchinhampton district in general. Stonesfield slate, Oxfordshire.

TRIGONIA COSTATA, *Sow., Var.* PULLUS. Tab. V, fig. 22, 22*a*.

CURVIROSTRA NON RUGOSA, *Luid.* Lithoph. Brit., t. 9, No. 714, 1760.
DONACITES COSTATUS, *Schoth.* Petref., i, p. 193, 1820.
LYRIODON COSTATUM, *Bronn.* Leth. Geog., t. 20, f. 4, 1836, 1851.
LYRODON COSTATUM, *Goldf.* Petref., ii, t. 137, f. 3, 1840.
TRIGONIA PULLUS, *Sow.* Min. Conch., t. 508, 1826.
— COSTATA, *Lamarck.* An. s. Vert., vi, p. 64, 1819.
— — *Parkinson.* Org. Rem., iii, t. 12, f. 4, 1811.
— — *Zeiten.* Wurtt., p. 78, t. 58, f. 5, 1834.
— — *Roemer.* Oolith., p. 97, 1835.
— — *Agassiz.* Mém. sur les Trigonées, p. 35, t. 3, f. 12—14, 1840.

Testâ subtrigonâ, umbonibus prominentibus recurvis, acutis, areâ magnâ, plicata et carinatâ.

In ætate juniori, cariná marginali acutâ et lævigatâ, cariná mediá et internâ denticulatâ.

Ætate adulto areâ in valvâ sinistrâ cariná marginali magnâ rotundatâ et indentatâ; cariná mediâ et internâ distinctâ et denticulatâ sed parvâ; superficie inter carinis plicis longitudinalibus densis interdum spinis acutis instructis; areâ in valvâ alterâ sine cariná mediâ plicisque longitudinalibus magnis, paucis intertiisque latis et profundis. Costis dorsalibus magnis, lævigatis, elevatis et curvatis, cariná marginali separatis.

Shell subtrigonal, umbones prominent, acute, recurved; area large, longitudinally plicated and carinated, dorsal surface costated. In the young state, the marginal carina is acute and smooth, the inner and mesial carinæ are denticulated. In a more advanced stage of growth, the area in the left valve has a marginal carina large, rounded, and deeply indented, the median and inner carinæ are distinct and denticulated, the spaces between the carinæ have numerous longitudinal plications, which are not unfrequently covered with asperities, or acute spinous elevations. In the right valve, the surface of the area is different; it is divided into two portions, the posterior portion being more depressed than the other, there is no distinct median carina, but the anterior portion of the area has two large indented plications, separated by wide interstitial spaces, ultimately two other plications are added. The longitudinal costæ are large, smooth, and gracefully curved, separated from the marginal carina by a smooth sulcus; the lanceolate space between the inner carinæ has a surface very similar to that of the area. Notwithstanding the frequency

with which this species has been figured and described, the foregoing definition will be found to differ from all which have previously been given; it is founded, however, upon observation of the form in its varieties and stages of growth without stint of examples. It is distinguished from other allied costated species, by characters which are chiefly supplied by the posterior slope, and which are constant and of importance. When from six to eight costæ have been perfected, the marginal carina acquires large denticulations, and subsequently continues to be indented transversely. The distinctly elevated median carina and finely reticulated surface of the left valve are very different from the corresponding parts of the right valve, the area of which has in its middle a longitudinal divisional line which separates the surface into two portions, the posterior portion being more depressed than the other; at first, there appears a kind of median carina, which subsequently is not to be distinguished from the other plications; these large plications do not occupy the entire surface of the area, but have between them, and more especially separating them from the marginal carina, wide and depressed interstitial spaces. Goldfuss states, that the apex of the right valve is more recurved, or advances before the other; this feature has occasionally been observed in specimens from the Cotswolds, it may therefore be regarded not as an accidental but as an occasional feature, which certainly is absent in the majority of specimens. Neither is this character altogether peculiar to the present species of *Trigonia*. A rigid comparison of specimens proves that the minute *Trigonia pullus* of the 'Mineral Conchology' from Ancliff, is only the germ of *Trigonia costata*, not of the typical large Inferior Oolite shell, but of a much smaller variety, which is abundant in the Great Oolite; adult specimens of this variety, which may be called *pullus*, have an equal number of costæ with the typical form, but the figure is less convex; the anterior border is not truncated, both that and the inferior border being regularly rounded. The linear dimensions never attain to half of the large Inferior Oolite form, an inconsiderable number only exceed an inch in length, but specimens of half an inch, or even less, are much more abundant. The peculiar features of the cardinal area above described are persistent in all the varieties of the species, and furnish a ready means of distinguishing it from allied costated forms, such as *Trigonia similis* of Bronn, *T. Meriani*, *monilifera*, *denticulata*, *papillata*, and *suprajurensis* of Agassiz; *T. costata* of Pusch, 'Polens Palæont.,' taf. vii, figs. 1, 2, is regarded by Agassiz as a distinct species, for which he proposes the specific name of *zonata*. *Trigonia costata* would appear to have very frequently been confounded with an abundant Kimmeridge clay species, but in the latter shell the area is alike in both valves, the marginal carina has not large denticulations, the general form is more elongated, the umbones much less recurved, the marginal carina is nearly straight, and the costæ are much more oblique. In the Minchinhampton district the *pullus* variety of *T. costata* is exceedingly abundant, surpassing in numbers those of the other *Trigonias* combined; the valves are usually disunited, and internal casts are never obtained; a length of 20 lines upon the marginal carina appears to be its utmost limit in size.

Localities. Everywhere in the shelly beds of the Minchinhampton district; in the Forest Marble of Wiltshire and Dorsetshire.

TRIGONIA COSTATA, *Sow., var.* ELONGATA. Tab. V, fig. 23.

Somewhat rarely an elongated variety of this well-known form occurs in the shelly beds of the Great Oolite; it is somewhat more convex than *T. pullus,* the marginal carina is remarkable for its general straightness and prominence, the costæ are less curved and are disposed with greater obliquity than in the other varieties, and the character of the area has nothing peculiar. It is not distinguishable from a shell from Cutch, figured and described by Mr. Sowerby in the 'Geological Transactions,' 2d ser., vol. v, pl. 21.

TRIGONIA FLECTA. Tab. V, fig. 20.

Testâ ovato-trigonâ, subcompressâ, areâ elongatâ, planatâ, transversè striatâ; carinis ejusdem subnullis, superficie costis angustis, horizontalibus rectis, posticè angulo flectis, angulo costarum subrecto.

Shell ovately trigonal, or oblong, rather compressed, area elongated and flattened, transversely striated; carinæ scarcely distinguishable, the middle portion of the area with a longitudinal furrow; the other portion of the shell with narrow straight nearly horizontal costæ, which at their posterior portions are suddenly bent upwards at a right angle, and become nodose, forming short perpendicular varices.

It differs from *T. angulata,* Sow., in the absence of tuberculated carinæ upon the area, in its flatness and in the costæ, which are more closely arranged, and have not the elegant curvature of the Inferior Oolite shell. The general figure is more oblong than *T. Goldfussii* and *T. undulata,* Agassiz, to both of which it has a certain resemblance in the character of its surface. It would seem to be rare; we have only met with a single example, which occurred in a rock too hard to permit the perfect exposure of the shell; its position is a bed somewhat shelly and situated a little beneath the Bradford clay.

Locality. The Tetbury Road station of the Great Western Railway.

TRIGONIA DUPLICATA, *Sow.* Tab. VI, fig. 2.

TRIGONIA DUPLICATA, *Sow.* Min. Con., t. 237, f. 4, 1819.

Testâ ovato-trigonâ anticè rotundatâ, postice productâ et rostratâ, umbonibus obtusis sub-recurvis; areâ angustatâ transversâ striatâ, medio sulco longitudinali, carinis parvis tuberculis minimis instructis; costis serratis ornatis; costulis prioribus concentricis et regularibus, aliis obliquis nonnunquam dichotomis.

Shell ovately trigonal, moderately convex, anterior extremity rounded, posterior extremity produced and rostrated, superior border rather concave; umbones mesial,

obtuse, slightly recurved; area narrow, transversely striated with a mesial longitudinal furrow; carinæ small, with densely arranged minute tubercles; costæ serrated; the first few costæ are regular and concentric, the others are directed obliquely downwards from the marginal carina to the lower border, they are nearly straight, some few are dichotomous and slightly waved, the serrations are irregular or unequal, which gives to the costæ a knotted aspect.

This species is not uncommon (more especially the external moulds), in the bed called *Trigonia grit*, a member of the upper division of the Inferior Oolite; in the Great Oolite it is very rare.

Localities. Minchinhampton Common, in the Great Oolite. The Cotswold hills generally, in the Inferior Oolite.

TRIGONIA IMPRESSA, *Sow.* Tab. V. fig. 24.

TRIGONIA IMPRESSA, *Sow.* Zool. Journal, iii, t. 11.
— — *Prevost.* Ann. Scien. Nat., iv, t. 18, f. 22, 23.
— — *Morris.* Catal. Brit. Foss., p. 103, 1843.

Testâ ovato—trigonâ subcompressâ, anticè productâ rotundatâ, posticè rectâ, obliquâ; umbonibus submedianis acutis; costis per series numerosis lævitèr arcuatis, subundulatis et tuberculatis, costis, anticis, obliquis, angustis, subrectis densè serratis, posticis curvatis, tuberculis parvis crebris; areâ angustâ, transversim striatâ, striis tenuibus crebris; cariná marginali nodulis parvis regularibus ornatis, cariná internâ transversim plicatâ; cariná mediâ sulco longitudinali.

Shell ovately trigonal, rather compressed, anterior side produced and rounded, posterior side straight, oblique, and compressed, umbones nearly mesial acute and very slightly recurved; costæ disposed in a numerous series which are moderately curved, little elevated, somewhat angulated and tuberculated. The anterior portions of the costæ are narrow and but little prominent; they are nearly straight, but are directed obliquely downward, and are more or less distinctly serrated or indented, but do not form distinct tubercles; posteriorly the costæ are more curved or rather angulated; they rise upwards to meet the marginal carina at a right angle and are distinctly tuberculated, the tubercles being small and closely arranged. The area is rather narrow and distinctly bounded by two carinæ; the marginal carina is small, it has regular elevated tubercles which are rather distantly arranged, the inner carina is plicated, an oblique furrow or line replaces the median carina, the surface of the area has at first a few prominent transverse plications, but these soon degenerate into striations which are fine and densely arranged; the lanceolate space between the inner carinæ is elongated and smooth.

The aspect of this little shell is peculiar, and its features are very persistent—few exceed an inch in length, and from this size to half an inch is its most frequent dimensions; they were eminently gregareous, and are numerously scattered over the thin laminæ of

Stonesfield slate, at very many localities, but have not hitherto been discovered in the shelly beds of the Great Oolite.

Localities. Stonesfield, Eyeford, and generally throughout Oxfordshire and Gloucestershire, where the Stonesfield slate is present.

TRIGONIA PHILLIPSI. Tab. VI, fig. 1.

Testâ ovato-trigonâ, convexâ, umbonibus submedianis obtusis, subrectis, areâ parvâ planatâ; carinâ marginali angustâ, tuberculis parvis, crebris ornatâ, carinâ internâ varicibus subdistantibus; superficie inter carinis plicis crebris transversis et sulco obliquo mediano instructo; valvis lateribus costis concentricis regularibus crebris elevatis, tuberculis parvis densè dispositis.

Shell ovately trigonal, convex, anterior border produced and rounded; posterior border truncated, umbones nearly mesial, obtuse, nearly straight and scarcely recurved, marginal carina nearly straight, narrow, and little elevated, ornamented with minute closely arranged tubercles, inner carina with a few prominent rather distantly placed varices; lanceolate space between the inner carinæ wide and smooth; the surface of the area between the carinæ is flattened, traversed transversely by prominent closely arranged plications, and divided in its middle part by an oblique furrow; the sides of the valves have very numerous elevated narrow concentric regular costæ, which are ornamented with small, equal, densely arranged tubercles.

This elegant shell possesses a considerable general resemblance to *Trigonia striata*, Sow.; like that shell the costæ are regular, concentric, elevated, and are furnished upon their upper surfaces with small tubercles; but the figure is essentially different; *T. striata* has the umbones recurved and pointed, the hinge margin posteriorly much excavated, the marginal and inner carinæ have a graceful curvature, and the posterior side of the shell is considerably produced; none of these features are observable in our species, the hinge margin of which is scarcely concave, the umbones obtuse, not prominent and recurved; the posterior side is likewise so short that the umbones appear to be nearly mesial; the costæ in our species are nearly twice as numerous, equally elevated, and the minute tubercles upon them are rounded and much more densely arranged, so that a little distance from the eye the tubercles are scarcely distinguishable. This comparison can only be made between the specimens themselves, for it happens that nearly all the figures hitherto published of *Trigonia striata* are very unsatisfactory, with the exception only of that in the *Petrefacten* of Goldfuss, which is excellent, and represents the adult condition of that species.

Trigonia Phillipsi occurs in soft Oolite, in the vicinity of Stamford and Denton, Lincolnshire, and has not been recognised in the Great Oolite of Gloucestershire.

Dedicated to Prof. John Phillips, whose philosophic researches have greatly contributed to the advancement of geological science.

TRIGONIA IMBRICATA, *Sow.* Tab. VI, fig. 8, 8*a*.

TRIGONIA IMBRICATA, *Sow.* Min. Con., t. 507, f. 2, 3.

Under this name, Mr. Sowerby has figured apparently an immature or young state of a species of *Trigonia* from Ancliff, of which the adult specimens have scarcely been recognised; this small form is shewn in the figure 8*a*; we believe, however, that the shell represented by fig. 8 belongs to a more advanced stage of growth; the peculiar imbrication of this species noticed by Mr. Sowerby appears to arise from the erosion of the concentric spinose tubercles which ornament the shell.

The young stage of this shell is described in the 'Mineral Conchology,' as being "Transversely oblong, depressed; with five or six concentric, dentated, subimbricated keels upon the rounded anterior side; posterior side obliquely truncated, ribbed. The carinæ upon the surface of this little shell resemble terraces one above the other; each is divided into four or five angular lobes."

Localities. Minchinhampton, (fig. 8, in the British Museum Collection;) Ancliff, Wiltshire.

CARDIUM, *Linn.* 1758.

Gen. Char. Shell equivalve subcordiform, umbones prominent, contiguous. Hinge with two cardinal and two lateral teeth in each valve; the cardinal teeth are approximate, oblique, crucially inserted, one with the other, lateral teeth remote.

CARDIUM SEMICOSTATUM, *Lycett.* Tab VII, fig. 6, 6*a*, *b*.

CARDIUM SEMICOSTATUM, *Lycett.* Annals Nat. Hist., 1850.

Testâ parvâ, ovato-orbiculari, convexâ, umbonibus magnis, medianis, concentricè et tenuissimè striatis; latere postico compresso, costulis crebris radiantibus decussatis.

Shell small, ovately orbicular, convex, umbones large, mesial; concentric striæ regular and faintly impressed; the posterior side is compressed, its concentric striæ are crossed by radiating closely arranged ribs.

The figure of this little species is wide towards the ventral border and narrow towards the umbones, the lunule is small or nearly obsolete; the convexity of the valves is moderate, and the flatness of the posterior side produces at its junction with the dorsal surface a well-defined oblique angle. It would seem to be rare in the shelly beds of the Great Oolite, but the Bradford clay of Wiltshire produces numerous casts of a *Cardium*, which we believe to belong to this species, and which attained a much greater development of growth; casts of this shell are also abundant adjacent to the Tetbury Road Railway station, a locality which is very prolific of the fossils of the Bradford clay.

The height and lateral diameter are about equal, varying from $2\frac{1}{2}$ to 5 lines.

Locality. Minchinhampton Common in the Great Oolite. It occurs likewise in the middle division of the Inferior Oolite of the same district.

CARDIUM STRICKLANDI. Tab. VII, fig.5, 5*a*.

CARDIUM STRIATUM. Geol. Chelt., *J. Buckmann* and *H. E. Strickland*, 1845, p. 97.

Testâ suborbiculari æquilaterali, ventricosâ, umbonibus medianis, contiguis, marginibus, arcuatis; latere postico lineis radiantibus crebris; dorso lineis concentricis crebris regularibus.

Shell suborbicular, equilateral, ventricose; umbones, mesial and contiguous, margins of the valves regularly rounded; surface ornamented with concentric regular small ridges, posterior portion with radiating closely arranged lines.

This small species is very abundant in the shelly beds of the Great Oolite, the concentric lines are most elevated and conspicuous in the smallest specimens, in those of the largest size which have a diameter of 10 lines, the lines are nearly or quite obsolete.

Height and lateral diameter equal, diameter through both the valves one third less.

Localities. Every Great Oolite quarry in the Minchinhampton district.

CARDIUM BUCKMANI. Tab. VII, fig. 2.

CARDIUM LÆVIGATUM, *Lycett.* Annals Nat. Hist., p. 422, 1850.

Testâ sublævi ovato-suborbiculari convexâ, umbonibus medianis prominulis incurvis, latere antico rotundo, postico obliquo, sed rotundo, basi arcuatâ; striis concentricis tenuissimis irregularibus.

Shell smooth, ovately orbicular, convex, umbones mesial, prominent, and incurved, anterior side rounded, posterior side oblique and rounded, base curved symmetrically; dorsal surface, with a few very fine and irregular concentric striæ.

The substance of the test is very thin, and its bad state of preservation together with the variety of the species render it difficult to exemplify it from any one specimen; much finer and more perfect specimens have been procured in the shelly freestone of Leckhampton hill, by the Rev. P. B. Brodie.

Height 22 lines; lateral diameter 24 lines; diameter through both the valves 15 lines. It has occurred in more than one of the shelly beds.

Locality. Minchinhampton Common.

CARDIUM SUBTRIGONUM. Tab. VII, fig. 3.

Testâ subtrigonâ, convexâ, umbonibus acuminatis contiguis anticis, latere postico elongato oblique declivi, lineis radiantibus undulatis; dorso striis tenuissimis concentricis irregularibus.

Shell subtrigonal, convex; umbones pointed, prominent, contiguous and anterior; posterior side elongated, sloping obliquely with radiating and waved lines; dorsal surface with very fine, concentric, irregular striæ. An ill-defined obtuse angle passes obliquely

from the umbones to the posterior and inferior angle, and forms a boundary to the radiating posterior lines. The posterior side is not excavated or flattened, as in some other trigonal species, but is rather convex.

It occurs very rarely near to the base of the Great Oolite, in a band of hard whitish argillaceous rock, but has not been found in the shelly beds.

Locality. The southern boundary of Minchinhampton Common.

CARDIUM-PES-BOVIS, D'ARCHIAC. Tab. VII, fig. 4, 4*a*.

CARDIUM PES-BOVIS, *D'Archiac.* Mem. Soc. Geol. Fr., tom. v, t. 27, f. 2, 1843.

Testâ nucleo subtrigonâ, convexâ; umbonibus magnis incurvis, dorso fornicato, angulo obliquo, acuto carinato; lunulâ magnâ cordatâ; latere postico angusto, excavato; dorso lineis longitudinalibus tenuissimis perpendicularibus ornatis.

Shell with the nucleus subtrigonal and convex; umbones large, incurved, dorsal surface with a ridge forming an oblique and acute angle; lunule large, cordate; posterior side narrow and excavated; dorsal surface with longitudinal, fine, perpendicular lines.

The large excavated lunule, fine perpendicular lines, and more erect mesial umbones, distinguish this from our *C. concinnum*, which latter is a much smaller species. It occurs very rarely in a whitish argillaceous rock near to the base of the Great Oolite.

Height, 30 lines; lateral diameter, 28 lines; diameter through both the valves, 22 lines.

Locality. The southern side of Minchinhampton Common.

CARDIUM CONCINNUM. Tab. VII, fig. 7*a*, *b*, *c*.

? CARDIUM MINUTUM, *D'Archiac.* Mem. Soc. Geol. Fr., v, t. 27, f. 4.
? — PES-BOVIS, *junior.*

Testâ ovato-orbiculari, obliquâ, umbonibus angulatis incurvis, latere antico rotundo brevi, lunulâ parvâ, latere postico compresso aut excavato, angulo obliquo obtuso carinato; dorso costulis radiantibus rotundis crebris, striis concentricis decussatis.

Shell ovately orbicular, oblique; umbones large, angulated, and curved forwards, anterior side rounded, short; lunule small, moderately excavated; posterior side flattened and excavated, bounded by an oblique and obtuse angled carina; dorsal surface with little ribs radiating, closely arranged, rounded, and decussated by regular, numerous, concentric striæ.

The posterior surface is ornamented in a manner similar to the other part of the shell, but so much more faintly marked that, in ordinary or not well preserved specimens, it appears smooth. The general figure has a considerable resemblance to the large *Cardium pes-bovis*, but the latter species is much higher, and more nearly equilateral.

Height, 9 lines; lateral diameter, 10 lines; diameter through both valves, 7 lines.

Localities. Minchinhampton Common, Bisley Common.

Isocardia. *Lam.* 1799.

Gen. Char. Cordiform, regular, ventricose; umbones prominent, distant, diverging, involute; hinge with two compressed cardinal, and one compressed lateral tooth in each valve; ligament external, bifid, diverging in the direction of the umbones.

Isocardia tenera, *Sow.* Tab. VII, fig. 1, 1*a*.

Isocardia tenera, *Sow.* Min. Con., p. 494, t. 295, f. 2, 1821.
— — *Deshayes.* Traité Elémentaire de Conch., ii, p. 27, t. 24, f. 6, 7.
Ceromya tenera, *Agassiz.* Etud. Cat., t. 8—e, f. 1—12, p. 34.
? Var. Isocardia tumida, *Phil.* Geol. Yorksh., i, t. 4, f. 25, 1835.

Testâ nucleo subtrigono, inflato; umbonibus medianis, altis antrorsum incurvis; latere antico lato, striis concentricis subtillissimis.

Shell with the nucleus subtrigonal, inflated; umbones mesial, elevated, and curved forwards and inwards; anterior side very wide, rather flattened, giving somewhat a three-sided figure to the nucleus; surface of the test with fine concentric striæ.

The convexity of the valves is so considerable that the diameter through both is almost equal to that of the height and length, but the length varies with the stages of growth, the younger forms being more produced laterally and less convex; the posterior side is always rather compressed, and usually exhibits an angle, which passes obliquely from the umbones backwards, but in the more inflated specimens it is obsolete; the valves appear to fit closely at their circumference, and the ventral border is regularly and elliptically curved. The anterior side is very wide, and somewhat flattened, giving a three-sided aspect to the general figure. The nuclei do not display any concentric striæ, and we have never found the test preserved.

Locality. It occurs somewhat rarely in the upper beds of the Great Oolite, two miles east of Minchinhampton, but has not been found in the shelly beds of the same formation.

Lucina, *Brug.* 1791.

Gen. Char. Inequilateral, orbicular, posterior side short or truncated, anterior side more produced. Hinge usually with two small cardinal, and two lateral teeth in one valve, one lateral tooth in the other; ligament external, but deeply excavated. Muscular impressions two in each valve, the anterior one narrow and lengthened, the posterior somewhat rounded; impression of the mantle not sinuated.

Lucina Bellona, *D'Orb.* Tab. VI, figs. 18, 18 *a*.

Lucina lirata, var. transversa, *D'Archiac.* Mem. Soc. Geol. France, v, t. 26, f. 3.
— Bellona, *d'Orb.* Prod. Paléont., 1, p. 309.

Testâ transversâ, ovato-orbiculari, plano-convexâ, anticè rotundatâ, posticè subsinuatâ, umbonibus medianis acutis, margine cardinali subrecto, oblique declivi, lunulâ parvâ excavatâ; superficie plicis concentricis magnis irregularibus, striis densissimis impressis.

Shell transverse, ovate, rather flattened, anterior margin rounded, posterior margin sinuated; umbones mesial and pointed; hinge margin lengthened, straight, and oblique; concentric folds rather irregular, elevated, and impressed with longitudinal, densely arranged, and very fine striations. An obscure elevation passes obliquely from the umbones to the inferior and posterior border. This shell presents considerable variety in its form and markings; young specimens are much more compressed, and their borders are very acute, the general outline is nearly orbicular, and the concentric plications are very distinct and regular: the adult shell becomes either of a suborbicular and convex, or of a transverse and more depressed form, and in both varieties the concentric elevations are placed at unequal distances; the suborbicular variety has a more excavated lunule, and the umbones are more directed forwards or oblique. The shell figured by M. D'Archiac, belongs to the transverse variety to which our Great Oolite specimens belong, but we are not without examples of the other form. It is absent in the shelly beds of the Great Oolite, being found only in mudstones, or a fine calcareous muddy sediment which has become limestone. It occurs very abundantly in the middle division of the Inferior Oolite in Gloucestershire, associated with *Nerinæa*, and a numerous suite of other Mollusks, but is almost absent when the organic *facies* consists of *Terebratulæ*. It reappears in the upper beds of the Great Oolite, forming a numerous colony in a compact marly rock, about one hundred feet above the Fuller's earth, where it is seldom that specimens much better than nuclei can be disengaged.

Dimensions. Transverse variety:—lateral diameter, 31 lines; height, 25 lines; diameter through both valves, 13 lines. Suborbicular variety:—lateral diameter, 26 lines; height, 24 lines; diameter through both valves, 13 lines.

Localities. In Great Oolite, two miles east of Minchinhampton. In Inferior Oolite, along the outer escarpment of the northern and middle Cotswold hills. Also near Stamford, and in other localities in Lincolnshire.

Lucina Bellona, *var. Depressa.* Tab. VI, fig. 15.

Testâ transversâ, subæquilaterâ, orbiculatâ, compressâ et lævigatâ; margine superiori anticè subhorizontali posticè recto declivi, striis concentris irregularibus.

Shell transverse, subequilateral, orbicular, compressed and smooth, superior margin anteriorly produced, and nearly horizontal, posterior margin straight and sloping; base regularly elliptical.

The lateral diameter, in regard to the height, is as eleven to nine; the umbones are nearly mesial, and pointed, but depressed; the concentric striæ are very slightly impressed, which gives to the shell a smooth and depressed aspect. It is not very common, but occurs in more than one of the shelly beds of the Great Oolite.

Localities. Minchinhampton and Bisley Commons.

LUCINA CRASSA, *Sow. var.* Tab. VI, fig. 13.

LUCINA CRASSA, *Sow.* Min. Con., t. 557, f. 3, 1827.

Testâ crassâ, suborbiculari, plano-convexâ, lateribus subæqualibus; umbonibus acutis medianis, cardine marginali recto, obliquo declivi; lunulâ parvâ obliquâ; basi arcuatâ, lineis concentricis crebris irregularibus.

Shell convex, suborbicular, the sides nearly equal; umbones acute, mesial; hinge margin straight, oblique, and sloping; lunule small, oblique; base regularly rounded, concentric lines closely arranged and irregular.

The umbones are mesial and curved forwards, so that the anterior side of the shell is less produced than is usual with the genus; the degree of convexity near the umbones is moderate, and less than in *L. obliqua.* It occurs very rarely well preserved in the planking beds of the Great Oolite.

The specimen figured is contained in the collection of the British Museum.

Worn specimens of this species, of which the shell has become thin, and the exterior markings obliterated, are difficult to distinguish from what we consider a distinct species, *L. rotundata,* and which may prove to be only a variety.

Locality. Minchinhampton Common.

LUCINA ROTUNDATA, *Roemer, sp.* Tab. VI, figs. 14, 14 *a.*

? ASTARTE ROTUNDATA, *Roemer.* Vers. Oolith., t. 6, f. 12, 1836.

Testâ subtransversâ, inæquilaterâ, oblique orbiculari, concentricè lineatâ, convexâ, anticè subproductâ, complanatâ; umbonibus parvis incurvis.

Shell somewhat transverse, inequilateral, obliquely orbicular, concentrically lineated convex, anterior side rather produced; umbones small, incurved.

Specimens vary both in the degree of convexity, and in the proportions between the lateral diameter and the height, but the former measurement always exceeds the latter. The concentric lines or plications are very irregular and faintly marked, so as to give a general smoothness to the surface.

It occurs somewhat rarely in the shelly beds of the Great Oolite, and has also been recognised in the upper ragstones of the Inferior Oolite.

Localities. Minchinhampton Common in the Great Oolite; Rodborough Hill in the Inferior Oolite.

The figure showing the hinge has been copied from a specimen in the British Museum collection.

Lucina despecta, *Phil.* Tab. VI, figs. 16, 17.

Lucina despecta, *Phil.* Geol. Yorksh., i, t. 9, f. 8, 1835.
— cardioides, *D'Archiac.* Mem. Soc. Geol. France, tom. v, t. 25, f. 6.
— despecta, *junior*, tab. nost. vi, f. 16.

Testâ suborbiculari, obliquâ, convexâ; umbonibus parvis acutis, postmedianis, latere antico producto, postico brevi; superficie lineis concentricis crebris irregularibus.

Shell suborbicular, oblique, convex, anterior side produced, posterior side short; umbones small, acute, situated posterior to the middle of the valves, and curved forwards; the surface with closely arranged, irregular concentric lines.

Having had the advantage (through the kindness of Mr. Bean) of comparing the original specimen (fig 17) figured in the 'Geology of Yorkshire,' we are enabled to affirm that *Lucina cardioides*, D'Archiac (Mem. Soc. Geol. Fran., vol. v, tab. xxv, fig. 6), represents the young of this species (Tab.VI, fig. 16); in that condition the shell is somewhat more convex, the concentric lines are prominent and less irregular than in the adult condition. *Lucina obliqua*, Goldfuss, (Petref., tab. 146, fig. 14,) is probably another synonym of the same species; these synonyms having been occasioned by the figure in the 'Geology of Yorkshire,' unaccompanied by any description not having been fully recognized.

The numerous specimens which we have examined present a considerable diversity in figure, depending chiefly upon the varying amount of obliquity; the substance of the test is thick, and in the ultimate stage of growth the concentric plications become both prominent and closely arranged. In the shelly beds of the great Oolite the greater number of specimens are diminutive; in the upper portion of the Inferior Oolite they are much larger.

Localities. Minchinhampton Common in the Great Oolite; Ponton, Lincolnshire; near Nailsworth, in the Inferior Oolite.

Corbis, *Cuvier*, 1817.

Idotæa, *Schumacher*, 1817.

Gen. Char. Shell transverse equivalve, umbones submesial, incurved, contiguous; surface imbricated or cancellated. Hinge, with two narrow triangular teeth, in each valve of which one is bifid, and two lateral teeth, the anterior of which are approximate, the posterior teeth remote. Muscular impressions lunulate, pallial impression simple.

Corbis lajoyei, *D'Archiac.* Tab. VII, fig. 12, 12*a*, *b*.

Corbis Lajoyei, *D'Archiac.* Mem. Soc. Geol. Fr., tom. v, t. 27, f. 1, 1843.

Testâ crassâ, convexâ, transversè elongatâ, umbonibus magnis medianis; anticè sub-

horizontali producto, posticè subrostrato, attenuato; margine cardinali subrecto, oblique declivi; costis concentricis crebris imbricatis; margine interno integro.

Shell thick, convex, transversely elongated, umbones large mesial; anterior side produced subhorizontal; posterior side more attenuated, slightly rostrated; hinge border nearly straight, elongated, and sloping obliquely; concentric costæ densely arranged, regular imbricated; inner margins of the valves smooth.

A very rare shell readily distinguished from other contemporaneous species by the finer and more densely arranged costæ.

Height 16 lines; length 25 lines; diameter through both the valves 13 lines.

Locality. Minchinhampton Common, where it occurs in the bed of coarse planking.

CORBIS LAJOYEI, *Var. cingenda.* Tab. VII, fig. 11.

Testâ ovato-rotundatâ concentricè costatâ; costis magnis subdistantibus prominulis lamelliformibus; latere antico brevi, marginibus rotundis.

Shell ovately rounded, convex, concentrically costated; costæ rather distant, regular, prominent, lamellar, anterior side short, margins rounded.

The figure is less elongated than in the preceding species, more especially the anterior side; the costæ are much more distantly arranged.

Height, one inch; length, an inch and a quarter; rare.

Locality. Minchinhampton Common, in the bed of coarse planking.

CORBIS ASPERA. Tab. VII, fig. 13, 13*a*.

CORBIS ASPERA, *Lycett.* Ann. Nat. Hist., Dec. 1850, pl. 11, f. 7.

Testâ ovato-elongatâ, convexâ, umbonibus subacutis prominulis, costis concentricis subacutis regularibus distantibus.

Shell ovately elongated, convex, umbones prominent, mesial, rather acute; concentric costæ regular, distinctly arranged, and rather acute.

Compared with *C. cingenda*, the figure is more elongated, the umbones more pointed, and the costæ are more elevated and distantly arranged.

Height, 8 lines, length, 11 lines; but larger specimens occur in the Inferior Oolite.

Localities. Minchinhampton Common, in the Great Oolite; the vicinity of Nailsworth, in the Inferior Oolite.

Sub-Genus, SPHÆRA, *Sow.*

Shell thick, subæquilateral, equivalve, globose, umbones large, contiguous, directed forwards, lunule small, but slightly excavated, ligament external, surface smooth, or impressed only with the folds of growth. Hinge, massive, with two cardinal teeth in the right valve, these are thick and united beneath the umbo; the posterior one is prominent, and placed transversely to the hinge plate, the anterior one is oblique and elongated

forwards, having a pit above it to receive the anterior lateral tooth of the other valve. Left valve with two cardinal teeth, of which the anterior one is prominent, somewhat conical, and disunited from the other, there is also a small approximate anterior lateral tooth. Each valve has likewise a distant posterior lateral tooth, which is not very prominent.

As *Sphæra* has a considerable general resemblance to *Corbis*: we will concisely indicate the features whereby they are distinguished. In *Corbis*, the anterior side is the most prominent; *Sphæra*, is equilateral and oblique. The surface of *Corbis* is always cancellated having a denticulated inner border; *Sphæra*, has its surface smooth, or is marked only with the lines of growth, and the inner margin is acute and smooth. The hinge in the right valve of *Corbis* consists of two narrow triangular teeth placed like the sides of the letter V, the angle being at the umbo, the anterior lateral tooth being separate and distinct; in *Sphæra*, the cardinal teeth are thick, not angular or pointed, and the anterior one forms a thickened oblique, lengthened process, before which there is no lateral tooth. In the left valve the arrangement of the teeth is likewise different; in *Sphæra*, the anterior and larger cardinal tooth is obtusely conical and projecting; in the other genus it is trigonal and depressed, and the anterior lateral tooth is differently situated with respect to the teeth of the other valve. Allowing, then, that *Sphæra* is nearly allied to *Corbis*, there would appear to exist sufficiently distinctive characters to demand their separation subgenerically.

Sphæra madridi. Tab. VII, fig. 14, 14*a*, *b*, *c*, *d*.

Cardium Madridi, *D'Archiac*. Mem. Soc. Geol. Fr., tom. v, pl. 25, f. 7, 1843.
Corbis Madridi, *D'Orb*. Prodome Paléont., i, p. 309.
? Cardium incertum, *Phil*. Geol. York., i, t. 11, f. 5, 1835.

Testâ crassâ subglobosâ, umbonibus magnis obliquis et contiguis. Valvis in ætate juniori lævigatis subdepressis; in ætate adulto globoso plicis incrementi rugis, concentricis et irregularibus.

Shell thick, subglobose; umbones large, directed obliquely forwards, and contiguous. In the young state the valves are rather depressed and smooth; in the adult state they become much more globose, and acquire concentric, irregular, and prominent folds of growth.

Considerable variation occurs in the figure of this species, the more globose specimens have the height and length of the valves almost equal, those which are more depressed have a greater length laterally and are nearly smooth; the latter characters are exhibited in specimens from the Inferior Oolite of Leckhampton Hill, where it occurs somewhat rarely. Our species ranks as one of the most abundant shells of the shelly beds of Great Oolite in the Minchinhampton district, and we have also detected it at several positions higher in the series, even to 120 feet above the Fuller's earth.

Localities. Minchinhampton and Bisley Commons, in the Great Oolite; in the shelly roe stone of the Inferior Oolite of Leckhampton Hill; and in the Forest Marble, near Frome.

Genus UNICARDIUM. *D'Orbigny*, 1847.

Shell thin, convex, ovately oblong; umbones contiguous, depressed; hinge margin elongated, nearly horizontal; margins of the valves rounded, not close fitting, but without any regular aperture. Hinge ligamentary, the ligament being external, supported by a thin shelly lamina, which is partly internal, and extends posteriorly the length of the hinge margin; beneath the umbo is a small depressed tooth in each valve, but these are nearly obsolete, and in the greater number of specimens cannot be distinguished. Muscular impressions elliptical; pallial impression simple. The external surface is destitute of ornament, but has large, concentric, irregular plications; the substance of the test is very thin.

The three species which we give as examples of *Unicardium*, belong to an extensive series of shells, several of which M. Agassiz has figured and described as *Mactromyæ*, but which are in fact perfectly distinct from another portion of the same genus, for which the name *Mactromya* may perhaps be retained; these latter are *Mactromya mactroides striolata*, *tenuis*, and *brevis;* these shells are distinguished by well-marked features, externally they have an oblique posterior angle, internally they have an anterior, oblique, elongated rib, and a large sinus in the palleal impression.

Three other species of the same author, viz., *M. globosa*, *æqualis*, and *rugosa*, have a figure much more convex, without any posterior angle; internally they are destitute of the anterior rib, and their palleal impression is simple; the latter group should therefore be removed from the *Myadæ*. M. D'Orbigny, ('Prodrome de Paléontologie,') has referred this group, together with other shells, to his new proposed genus *Unicardium*, the type of which is *Corbula cardioides*, of Phillips. *Unicardium* is described as resembling *Cardium*, but having only a single cardinal tooth in each valve.

Unicardium comprises a numerous group of species, several of which are so nearly allied in form as to be with difficulty distinguished. They occur throughout the Lias, the lower, the middle, and the upper Oolitic rocks of Europe, and it is probable that many species remain undescribed; they occur indifferently in beds of clay, in lias limestone, and in shelly oolite, in the latter case the valves are always disunited, but in the lias and other clays, and argillaceous limestones, the valves are invariably in apposition. Their habits were not gregareous, but, on the contrary, they always occur sparingly, and from the thinness of the test, have often sustained fracture or compression. From the borders of the valves not being close fitting, and perhaps from a considerable amount of lateral motion which the kind of union in the valves would permit, one valve frequently overwraps the other, producing a mistaken appearance of inequality in the valves, which may have led to the species first figured in the 'Geology of Yorkshire,' having been assigned to *Corbula*.

We regard *Unicardium* as presenting a considerable resemblance to certain species of *Lucina*, and would arrange it in the Malacological series near to that genus.

UNICARDIUM VARICOSUM, *Sow.*, Sp. Tab. VIII, figs. 7, 7*a*, *b*; 8*a*, *b*.

VENUS VARICOSA, *Sow.* Min. Con., t. 296, 1819.
? UNICARDIUM CORBISOIDEUM, *D'Orbigny.* Prod. de Paléont., i, p. 309, 1850.
— VARICOSUM, *D'Orbigny.* Ibid., p. 310.

Testâ subglobosâ, umbonibus magnis, medianis antrorsum incurvis, lateribus brevibus, posticè subtruncato, marginibus rotundis, plicis concentricis tenuibus irregularibus.

Shell very thin, subglobose; umbones large, mesial directed forwards; sides of the shell short, more especially the posterior side, which, differing from the usual form of the genus, is somewhat shorter than the other side; the margins of the valves are rounded and slightly irregular; the concentric plications are not prominent.

The nuclei of this species are impressed with one or more strongly-marked grooves, which pass downwards from the umbones towards the inferior border in each valve. Mr. Sowerby remarks that this species is "not remarkable for anything but the furrows that occur along the middle of the specimens, all of which are casts in a light-coloured limestone; the furrows are two upon each valve, one of them much larger than the other, and terminated before reaching the edge by a deep hollow; corresponding ridges must have existed inside the shell, but whether they were visible externally cannot now be discovered; the concentric furrows that are strongly marked upon some specimens would seem to indicate a thin shell. It is nearly globose, but not so deep as long; the line of the hinge is two thirds as long as the shell, and nearly straight; other characters of the hinge are not discoverable; the beaks are much incurved." (Min. Con., vol. iii, p. 173.)

Localities. Casts occur in the upper marly deposits of the Oolite at Felmersham, Blisworth, Kingsthorpe, Oundle, &c. The shells occur rarely in the Great Oolite of Minchinhampton Common.

UNICARDIUM IMPRESSUM. Tab. VIII, fig. 9*a*, *b*, *c*.

Testâ ovato-obliqua aut subquadratâ, convexâ; umbonibus contiguis submedianis, depressis, latere antico brevi, margine ejusdem rotundato, latere postico magis producto margine oblique declivi, margine superiori subhorizontali recto, basi curvatâ, plicis concentricis magnis irregularibus.

Shell obliquely ovate, or subquadrate, convex; umbones submedian, contiguous, and depressed; anterior side short, its margin rounded; posterior side more lengthened, its margin sloping obliquely; superior border nearly horizontal and straight, gaping slightly; lower border curved; concentric plications large and irregular.

In its young state this species is very delicate, more transverse or oblong, and depressed, its surface is nearly smooth. It is only in a very advanced stage of growth that the surface acquired large concentric folds, and the figure becomes subglobose, but the degree of obliquity and convexity varies very much even with individuals of the same size. The

ligamental area is elongated, smooth, and lanceolate, its margins are not in contact, but have between them a distinct elongated aperture, which is beneath the cushion of the ligament. It occurs very frequently in a crushed or imperfect condition, a circumstance which seems to indicate that it was not habitually a mud living species.

It is met with somewhat rarely throughout the shelly beds of the Great Oolite, and likewise in the middle division of the Inferior Oolite in Gloucestershire.

Compared with *U. globosum*, Ag., it is more elongated, depressed, and oblique; as the test is always preserved, and the valves disunited, we are precluded from examining the characters of the internal casts.

Localities. Minchinhampton and Bisley Commons in the Great Oolite; Leckampton and Selsley Hills in the Inferior Oolite.

UNICARDIUM PARVULUM. Tab. VIII, fig. 6, 6*a*.

Testâ parvâ subdepressâ, ovato-oblongâ; umbonibus subanticis acuminatis, latere antico brevi, postico elongato; basi curvatâ, lineâ cardinis horizontali, subrectâ; superficie subcompresso plicis concentricis irregularibus.

Shell small, rather depressed, ovately oblong; umbones anterior and acute, anterior side short, posterior side elongated, base curved elliptically; hinge border lengthened, horizontal, and straight; surface somewhat compressed with irregular concentric plications.

This little species has less convexity, and is more oblong than is usual with this genus; the hinge border is nearly horizontal, but rounded at its extremity, and the valves do not gape perceptibly at the ligamental area; in many specimens there is an obscurely defined angle directed from the umbo to the antero-ventral border, and in common with other species there is much variation in the degree of obliquity and convexity. One of our specimens, a portion of which exposes the internal cast, has a very fine radiating striæ, of which there is no trace upon the external surface of the shell. It occurs not uncommonly in the shelly beds of the Great Oolite, and has also been recognised in the upper portion of the formation.

Height, 7 lines; length, 9 lines.

Locality. Minchinhampton Common.

CYPRICARDIA. *Lam.* 1801.

Gen. Char. Shell equivalve, inequilateral, oblique, transverse, anterior side short; hinge with two or three cardinal teeth in each valve, and one lateral tooth. Muscular impressions two in each valve; ligament external.

CYPRICARDIA BATHONICA, *D'Orb.* Tab. VII, fig. 8, 8*a*, *b*, *c*.

CYPRICARDIA BATHONICA, *D'Orbigny.* Prodrome de Paléont., p. 308, 1850.

Testâ ovato, transversâ, inæquilaterâ, turgidâ, cordiformi, postico angulatâ et elongato lævigatâ; umbonibus magnis obliquis recurvis, cardine bidentato dentibus lateribus distantibus elongatis; margine integro postice subsinuato.

Shell ovate, transverse, inequilateral, ventricose, heart-shaped, posterior side angulated, elongated and smooth; umbones large, oblique, slightly recurved; hinge with two large cardinal teeth and one distant elongated posterior lateral tooth; margin of the valve entire, slightly sinuated posteriorly.

This species approaches near to *C. cordiformis*, Deshayes, but it is more oblique or lengthened posteriorly; it occurs rather abundantly in the bed of coarse planking.

Height, 21 lines; length, 27 lines; diameter through the valves, 17 lines.

Localities. Minchinhampton Common; Ponton, Lincolnshire; in the Fuller's earth of Box Tunnel, near Bath.

CYPRICARDIA ROSTRATA, *Sow.* sp. Tab. VII, fig. 9, 9*a*, *b*.

ISOCARDIA ROSTRATA, *Sow.* Min. Con., t. 295, f. 3, 1819.
— — *Goldf.* Petref., p. 210, t. 140, f. 12, 1840.
— — *Morris.* Cat., p. 88, 1843.
? CARDIUM BEAUMONTI, *D'Archiac.* Mém. Soc. Géol. Fr., tom. v, t. 26, f. 4, (nucleus,) 1843.

Testâ subtrigonâ, convexâ; umbonibus angulatis, antemedianis, prominulis; lunulâ parvâ excavatâ; latere antico rotundo, postico truncato angulo obliquo carinato; dorso lævigato; lineis incrementi paucis, irregularibus.

Shell subtrigonal, convex; umbones angulated, prominent, anterior, and incurved; lunule small, excavated; anterior side rounded, posterior side truncated and somewhat concave, its inner border forming a prominent and obtuse angle; the surface of the shell is smooth, and marked only with a few faintly impressed lines of growth.

The hinge line posteriorly is nearly horizontal, forming an angle with the posterior sloping margin, the margin itself forming an acute angle with the inferior borders.

Height, 10 lines; lateral diameter, 11 lines; diameter through both the valves usually about 8 lines, but the latter measurement varies in individuals.

It occurs abundantly in the form of nuclei in the upper portion of the Great Oolite, and very rarely with the test preserved, in the shelly beds of the formation. The figure of D'Archiac has a greater height than is exhibited by our specimens, and the umbones are less inclined forwards, but looking at the great varieties of figure which the nuclei assume, we do not see any sufficient reason to regard it as a distinct species.

Localities. Minchinhampton Common; Oxfordshire; Northamptonshire.

CYPRICARDIA NUCULIFORMIS, *Roemer*, sp. Tab. VII, fig.10, 10*a*, *b*..

CYRENA NUCULIFORMIS, *Roemer*. Verst. Oolith., t. 9, f. 13, 1836.

Testâ subtrigonâ aut cuneiformi, inæquilaterâ; umbonibus anticis contiguis, margine antico rotundo, postico elongato et recto, basi curvatâ, subsinuatâ, cardine bidentato dentibus lateribus magnis.

Shell subtrigonal or cuneiform, very inequilateral; umbones anterior, contiguous; anterior margin rounded, posterior margin elongated and straight; base curved, slightly sinuated; hinge with two cardinal teeth in each valve and a large lateral tooth placed at some distance from the others. The general form is rather compressed; the concentric plications are distinct, but not very prominent.

It occurs somewhat rarely in the shelly beds of the formation, also occasionally in the upper beds in the form of casts.

Height 8 lines; length, 12 lines; diameter through both the valves, 5 lines.

Locality. Minchinhampton Common.

HIPPOPODIUM, *Sow.* 1819.

A solitary specimen of this genus has been found by us in the Stonesfield slate of Oxfordshire; unfortunately it is in too imperfect a condition for description or comparison, but it bears a general resemblance to some specimens of *H. ponderosum*, Sow., and we have recorded the fact of its occurrence with the view of drawing further attention to the subject.

MYOCONCHA, *Sow.*, 1824.

Gen. Char. Shell equivalve, transverse, very inequilateral, umbones small, depressed, subterminal; hinge border lengthened, straight, having an external elongated groove parallel with it, and extending from the umbo posteriorly to the extremity of the shell, ventral margin entire, not sinuated, and parallel with the hinge border. Hinge, with an elongated cardinal tooth in the right valve, situated beneath the umbo, and which is received into an elevated cavity in the other valve; there is also in each valve a lengthened posterior thickened plate or rib, serving to support the ligament, which is external. Muscular impressions, two in each valve, of which the anterior are rounded, and bounded internally by an elevated and thickened plate which projects from beneath the cardinal tooth; posterior impression expanded; palleal impression not sinuated.

MYOCONCHA CRASSA, *Sow.* Tab. III, fig. 16, 16*a*.

MYOCONCHA CRASSA, *Sow.* Min. Con., t. 467, 1824.
— — *Bronn.* Leth. Geog., p. 237, t. 20, f. 15, 1851.
MYTILUS SULCATUS, *Goldfuss.* Petref., t. 129, f. 4, 1840.

Testâ subellipticâ, fornicatâ, concentricè striatâ, lineis radiantibus irregularibus, tenuissimis undulatis, sæpissime obsoletis; umbonibus parvis; sulco elongato postico semper notato.

Shell subelliptical, ridged, concentrically and irregularly striated, with very fine longitudinal waved lines, frequently obsolete; umbones small; posterior elongated, external groove always visible.

The few Great Oolite examples of this well-known shell are of much smaller dimensions than those which are so abundant in the lower or Ammonitiferous beds of the Inferior Oolite at Dundry, they are likewise more compressed; they have only a moderate degree of thickness, and the fine lines radiating from the umbones can rarely be discovered; these variations are such as might be expected to occur in a species which possesses so considerable a geological range, and they are moreover precisely similar to those which the species presents when it is found in the middle or freestone division of the Inferior Oolite, in Gloucestershire.

Dimensions of the larger Great Oolite specimens:—

Height, 14 lines; longitudinal diameter, 27 lines; diameter through both the valves, 8 lines.

Localities. Minchinhampton Common; Barnack, Northamptonshire; Ponton, Lincolnshire.

MYOCONCHA ACTÆON, *D'Orbigny.* Tab. III, fig. 17, 17*a*.

MYOCONCHA ACTÆON, *D'Orbigny.* Prodrome de Palæont., p. 312, 1850.

Testâ ovato-oblongâ subdepressâ, marginibus superioribus et inferioribus parallelis, margine postico subrecto, umbonibus parvis, depressis, plicis concentricis paucis irregularibus.

Shell ovately oblong, the superior and inferior borders straight and nearly parallel, the posterior border nearly square; the umbones very small and depressed, posterior sulcus distinct; concentric plications few and irregular.

On comparison with *Myoconcha crassa*, this shell is more depressed, less pointed at the extremities, the posterior border more especially being quadrate; the superior and inferior borders are more nearly straight or parallel, and no radiating lines are visible upon the surface.

Length, one inch and three quarters; height, one inch.

Locality. Minchinhampton Common, where it occurs in the bed of coarse planking.

MYOCONCHA ELONGATA. Tab. III, fig. 18.

Testâ soleniformi, elongatâ, subdepressâ, umbonibus parvis contiguis depressis, latere antico angusto, postico latiore et compresso, marginibus superioribus et inferioribus rectis, parallelis, plicis incrementi paucis tenuibus.

Shell pod-shaped, elongated, rather depressed; umbones small, contiguous, depressed;

anterior side, narrow, posterior side wider and more compressed, upper and lower margins straight and nearly parallel, concentric plications few and delicate.

A species unusually elongated and compressed posteriorly; it appears to be destitute of radiating lines, judging from three examples which are the whole that have passed under our notice.

Height, 8 lines; length, 21 lines; diameter through both the valves, 6 lines.

Localities. Minchinhampton Common, in the Great Oolite; it occurs also in the Inferior Oolite of the same district.

Pachyrisma, *Morris* and *Lycett*, 1850.

Pachyrisma, *Deshayes*, 1851.

Testâ oblongâ, cordiformi, æquivalvi, valdè inæquilaterali, crassissimâ, læviusculâ aut concentricè striatâ; umbonibus magnis angulatis contiguis et involutis, anticè recurvis; cariná obtusâ, dorsali, posticâ; ligamento externo, crasso, subelliptico, umbones versus bifurcato. Dente et foveâ cardinali unicâ in utráque valvâ; dente magno, obtuso, irregulariter conico lateribus compressis, et dente parvo accessorio in valvâ dextrâ; impressionibus muscularibus duabus; posticâ obliquâ in laminâ internâ sitâ; anticâ oblongâ excavatâ processu dentiformi supernè instructâ.

Shell oblong, cordiform, equivalve, very inequilateral, thick, with large, angulated, contiguous, and involute umbones diverging anteriorly; an obtuse-angled posterior dorsal keel divides the surface into two portions; ligament large, external, somewhat elliptical and bifurcated towards the umbones, to the apices of which a groove passes for its reception, as in *Isocardia*. Hinge massive, consisting of a single large, obtuse, conical tooth in each valve, compressed laterally; and a pit by the side of it to receive the corresponding cardinal tooth of the other valve; the right valve has, in addition, a small accessory tooth placed upon the anterior margin of the cardinal pit. Muscular impressions two, the posterior one is supported upon a raised projecting plate, which descends from beneath the hinge obliquely backwards, the position of which is marked upon the external surface by a slight furrow; anterior impression deeply excavated, of an oblong form, and with a small tooth upon its upper margin.

This genus has some affinities with *Isocardia*, *Opis*, and *Megalodon*, the latter of which it appears to represent in the Jurassic period, and with it may constitute a family "*Megalonidæ*." It is distinguished from *Megalodon* by the cardinal tooth in the right valve not having been divided as in the latter genus. *Megalodon* has the anterior muscular impression upon a somewhat raised or lamelliform plate; but the posterior raised plate of *Megalodon* presents a near approximation to that of *Pachyrisma*. From *Opis* it is sufficiently distinguished by the characters of the dentition. The dichotomous ligament resembles that of *Isocardia*, and when viewed anteriorly, it reminds us of the recent *Isocardia cor.*, with its large and graceful diverging umbones. *Pachyrisma*, then, may be

described as a *Megalodon-like* shell, the dental characters of which, however, are peculiar, combined with the external figure of *Opis* and *Isocardia*.

A detailed description of this genus and its affinities will be also found in the valuable and useful work of Mons. G. P. Deshayes, the 'Traité Elémentaire de Conchologie.'

PACHYRISMA GRANDE, *Lycett*. Tab. VIII, figs. 1—5.

PACHYRISMA GRANDE, *Morris* and *Lycett*. Journal of the Geol. Society, 1850, p. 401.
— — *Deshayes*. Traité Elémentaire de Conch., ii, p. 187, pl. 32*bis*, f. 1—3.

Testâ cordatâ, elongatâ; carinâ obtusâ, dorsali, posticâ, latere antico brevi; latere postico profundé depresso; striis numerosis, concentricis, irregularibus.

Shell cordate, with an obtuse, prominent, posterior, dorsal keel; posterior side deeply excavated, with a mesial oblique furrow, forming with that of the other valve a cordiform surface; striæ numerous, concentric, and irregular.

In young specimens the form is less gibbous, the small dental processes are very distinct, but the large tooth has little of the prominence which it afterwards attains, it not having acquired the conical projecting form as in the adult state.

The massive character of the hinge, umbones, and anterior side of the shell, presents a striking contrast with the attenuation of the posterior side; this latter portion is consequently very rarely well preserved, although the internal projecting oblique plate must have contributed to strengthen this part; the small dentiform processes bordering the anterior muscular impression are just in contact when the valves are closed, that of the left valve being received into a small depression above the corresponding process of the right valve, the tooth of the right valve resting within the muscular impression of the opposite one. The thickness of this portion of the test is such that in an individual which measured six inches across, it was upwards of three quarters of an inch.

Our shell nearly resembles a figure published by Catullo[1] of a cast of a shell named *Cardium triquetum*, by Wolfen,[2] from the Jurassic strata of Antello, near Cardonino. The shells figured by Pusch, (Polens. Palæont., t. vii, figs. 8, 9,) under the names *Isocardia exaltata*, and *I. ventricosa*, have some affinity with our shell, and may belong to the same genus.

Geological position. This species occurs near to the base of a series of hard cream-coloured limestone beds which extend from Minchinhampton to Cirencester, the base line of which has at one locality been ascertained to be forty-five feet above the Fuller's earth; the position is therefore higher than the shelly weatherstones of Minchinhampton Common, and near to the middle of the formation. The limestones have, in the aggregate, a very considerable thickness, but become browner and more sandy upwards. It is impossible to disengage the crystalline tests from the hard limestone, but an accidental seam of softer

[1] 'Saggio di Zoologia Fossile,' de T. A. Catullo, t. 1, f. D, E, F, f. 2 A; Padua, 1827.
[2] 'Abhandl. von Kärnthenschen pfauenschen. Helmintholith.,' p. 48.

and less homogeneous rock has enabled us to disclose the interior of the valves in many instances. The valves occur of all sizes, both in conjunction and disunited; the habits of the species were gregareous to the almost entire exclusion of other Mollusks, a few casts of *Purpuroidea* and *Natica*, however, accompany it. *Pachyrisma* occupies a vertical thickness of only half a yard, and its horizontal extension would likewise appear to have been very limited; hitherto it has been found only at two localities of the same neighbourhood.

Locality. The vicinity of Minchinhampton and Chalford.

Opis. *Defrance*, 1825.

Cardita, Sp., *Sow.*, 1819.

Gen. Char. Shell subtrigonal or cordate, thick, the valves convex, arched, the posterior side being separated from the anterior by an angle or carina; umbones prominent, large, curved spirally outwards and forwards; lunule large, cordiform, sometimes deeply excavated. Hinge massive, the right valve with a large obliquely pyramidal tooth compressed laterally, posterior to which is a narrow and deep cavity, with parallel sides; the left valve with a large subquadrate cavity to receive the tooth of the other valve, and a small accessory tooth extending along the posterior margin. Ligament external. Muscular impressions strongly marked and rounded; palleal impression simple.

Opis lunulatus, *Sow.* var. Tab. VI, figs. 3, 3 *a*, *b*, *c*.

Cardita lunulata, *Sow.* Min. Con., p. 55, t. 232, f. 1, 2, 1819.
Opis lunulatus, *Morris.* Catalogue, p. 96, 1843.
— — *Blainville.* Malacol., t. 70 *bis*, f. 1,

Testâ trigonâ, ventricosâ, concentricè lineatâ; umbonibus magnis involutis, carinâ dorsali subacutâ, elevatâ, latere postico abrupte-plano; lunulâ cordatâ profundâ, marginibus acutis.

Shell trigonal; umbones large, angular, terminal, and curved outwards, the posterior side bounded by a prominent and acute angled carina; anterior side with closely arranged regular concentric lines; posterior side flattened or slightly excavated, smooth, or with faintly-marked oblique lines; lunule smooth, cordate, large, deep, its margins acute.

This thick shell, with the valves disunited, is one of the most abundant bivalves of the Great Oolite shelly beds; the size of the lunule varies very much, as likewise does the number and prominence of the concentric lines; occasionally, indeed, the surface appears to have become quite smooth in the more advanced stage of growth.

The height and lateral diameter are of equal dimensions; the diameter through both the valves is one third less.

Upon comparison with the typical form from Dundry, this variety is observed to be smaller, less elongated, the lunule usually larger, and its margins more acute, but we do not regard these differences of more importance than might be expected to occur in shells procured from a different stratum and locality.

Localities. The whole of the Minchinhampton district in the Great Oolite; Ponton, Lincolnshire.

TAB. I.

Fig.

1, 1 *a*. Ostrea acuminata, *page* 3.

2. „ gregarea, *var.*, *p.* 4.

3, 3 *a*. „ Sowerbii, *p.* 4.

4. „ rugosa, *p.* 2.

5, 5 *a*. „ costata, *p.* 3.

6, 6 *a*. „ sub rugulosa, *p.* 4.

7. Exogyra auriformis, *p.* 5.

8, 8 *a*. Placunopsis Jurensis, *p.* 6.

8 *b*. Interior of Ditto, showing muscular impression.

9, 9 *a*. Placunopsis socialis, *p.* 7.

10. „ radians, *p.* 7.

11, 11 *a*. „ ornatus, *p.* 7.

12, 12 *a*. Pecten vagans, *p.* 8.

13. „ annulatus, *p.* 12.

14. „ peregrinus, *p.* 9.

15, 15 *a*. „ retiferus, *p.* 9.

16. „ hemicostatus, *p.* 10.

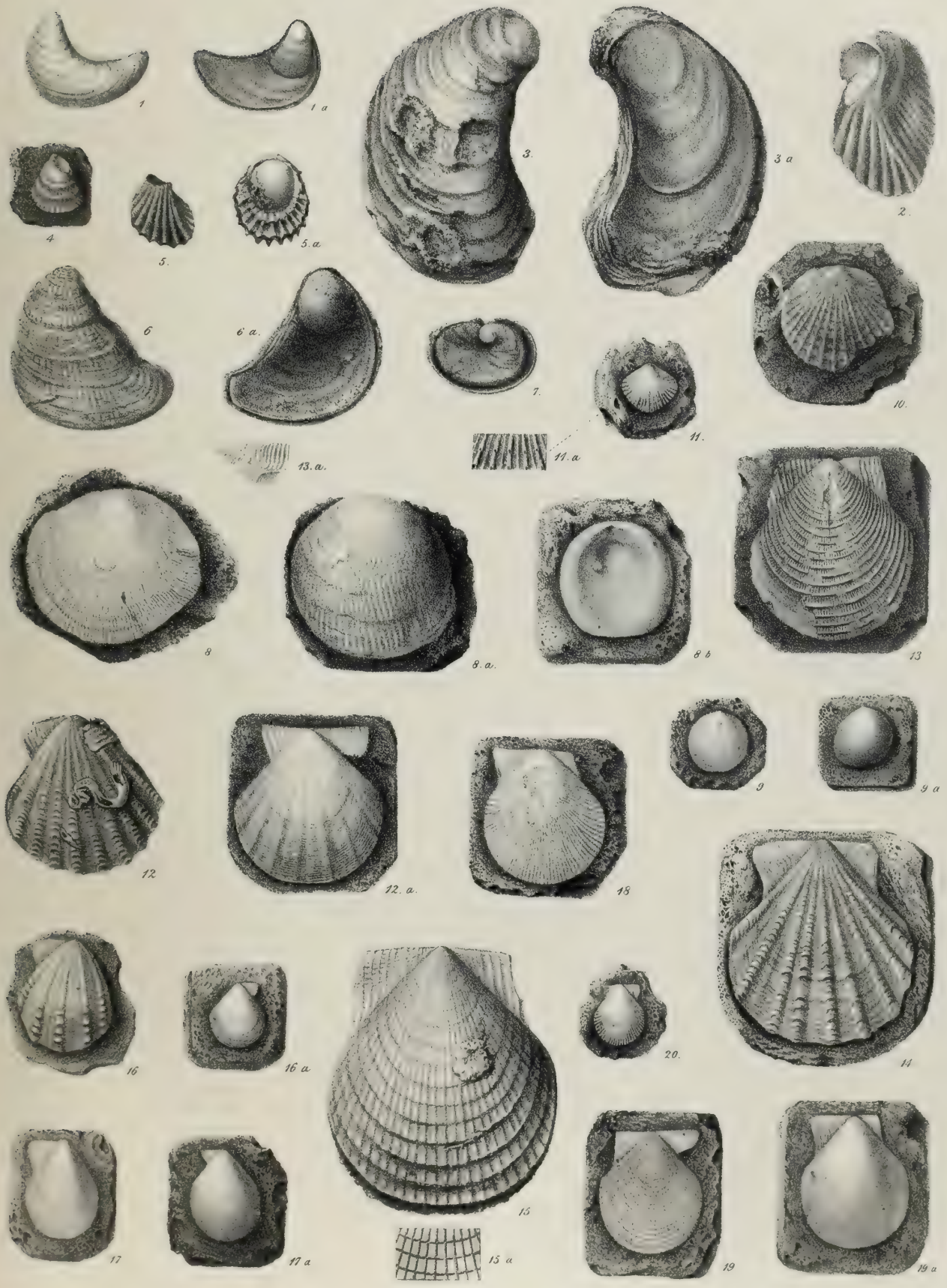
17, 17 *a*. „ personatus, *p.* 11.

18. „ arcuatus, *p.* 11.

19, 19 *a*. „ clathratus, p. 13.

20. „ Woodwardii, *p.* 8.

Tab. I.



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TAB. II.

Fig.

1, 1 *a*. Pecten lens, *p*. 11.

2, 2 *a*. Hinnites velatus. *p*. 14.

3, 3 *a*. „ tegulatus, *p*. 14.

4. Plicatula tuberculosa, *p*. 15.

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6, 6 *a*. Avicula costata, *p*. 15.

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8. Pteroperna costatula, young of, showing the costated surface, *p*. 18.

9. Gervillia crassicosta, *p*. 23.

10. Pteroperna emarginata, *p*. 19.

11, 11 *a*. „ pygmæa, *p*. 19.

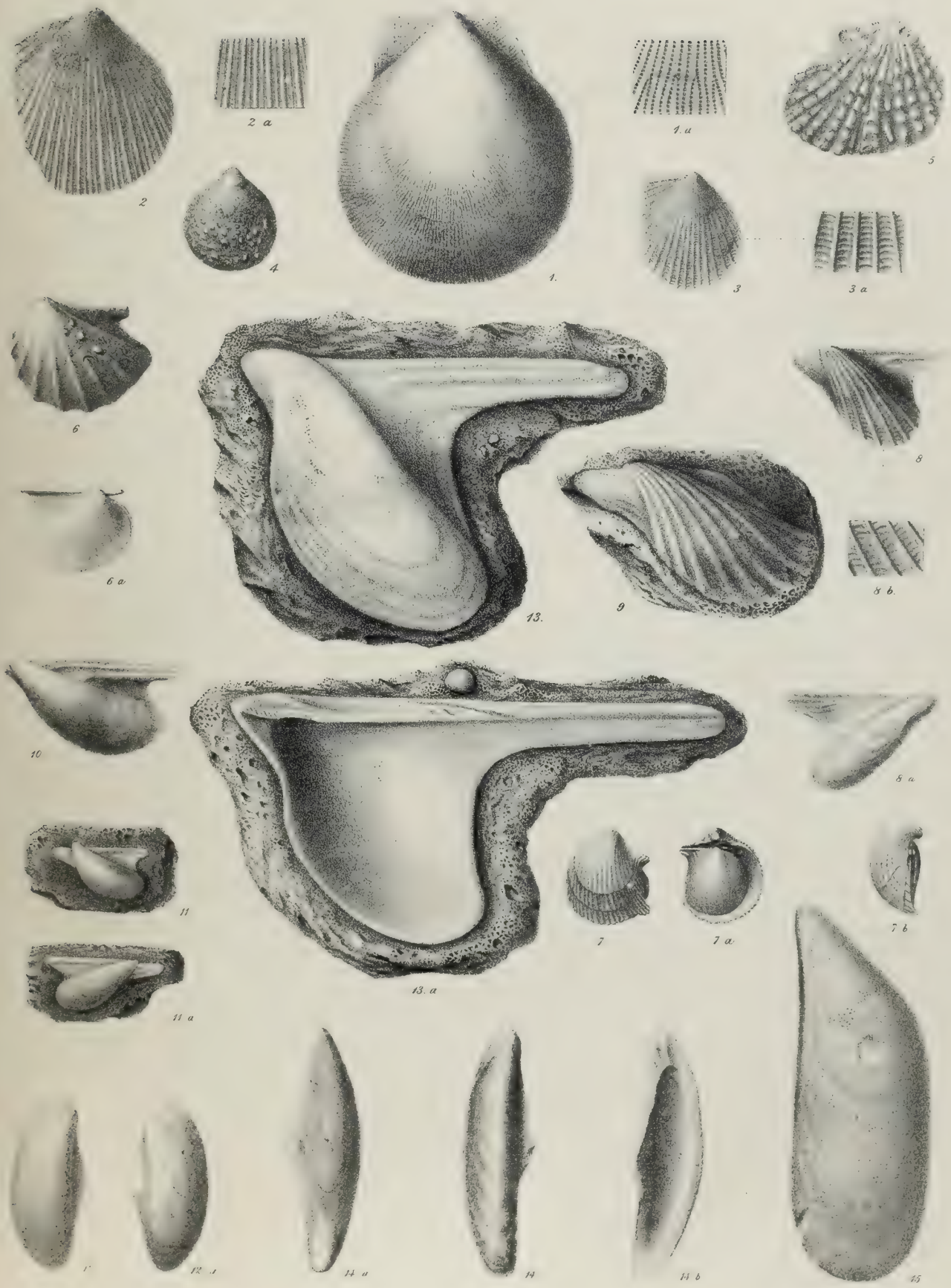
12, 12 *a*. Gervillia ovata, *p*. 22.

13. Pteroperna costatula, *p*. 18.

13 *a*. Interior of ditto, showing muscular impression and hinge area, *p*. 18.

14, 14 *a*, *b*. Gervillia monotis, *p*. 22.

15. „ Bathonica, *p*. 21.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11 a
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7 a
7 b
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12. a
14. a
14
14 b
15

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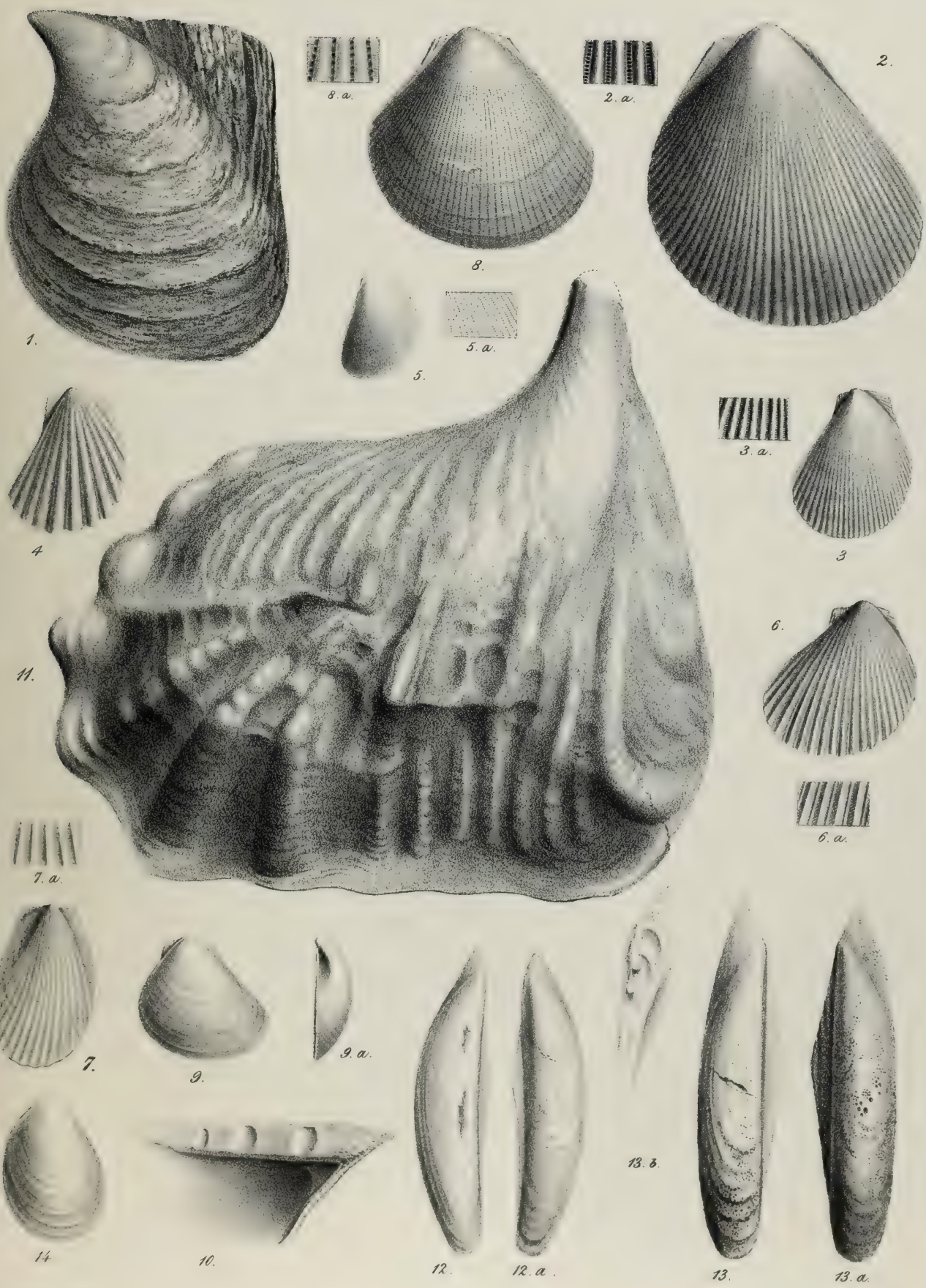
Tab. III.



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18. „ elongata, *p.* 77.
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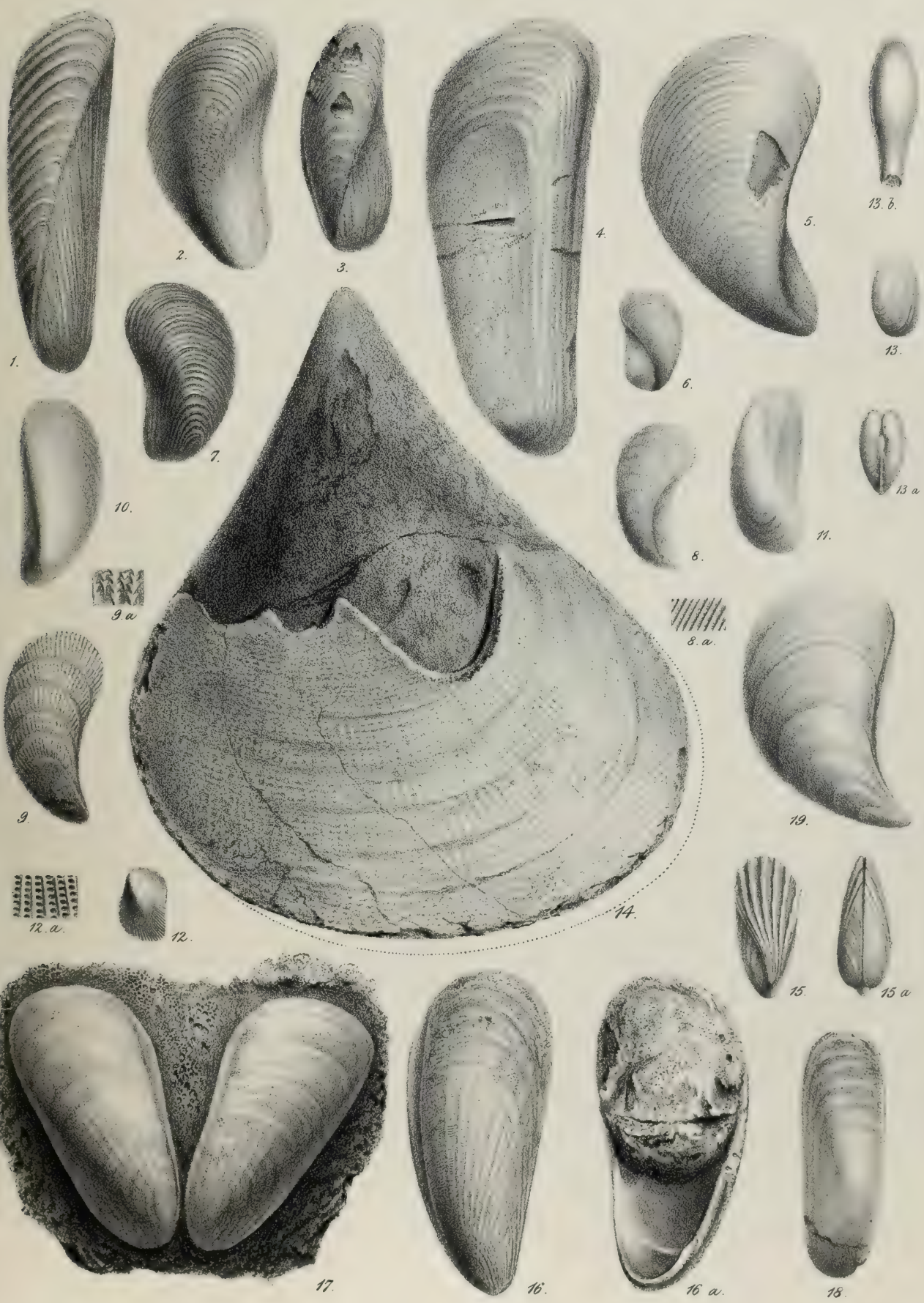

Achilles. del et lith

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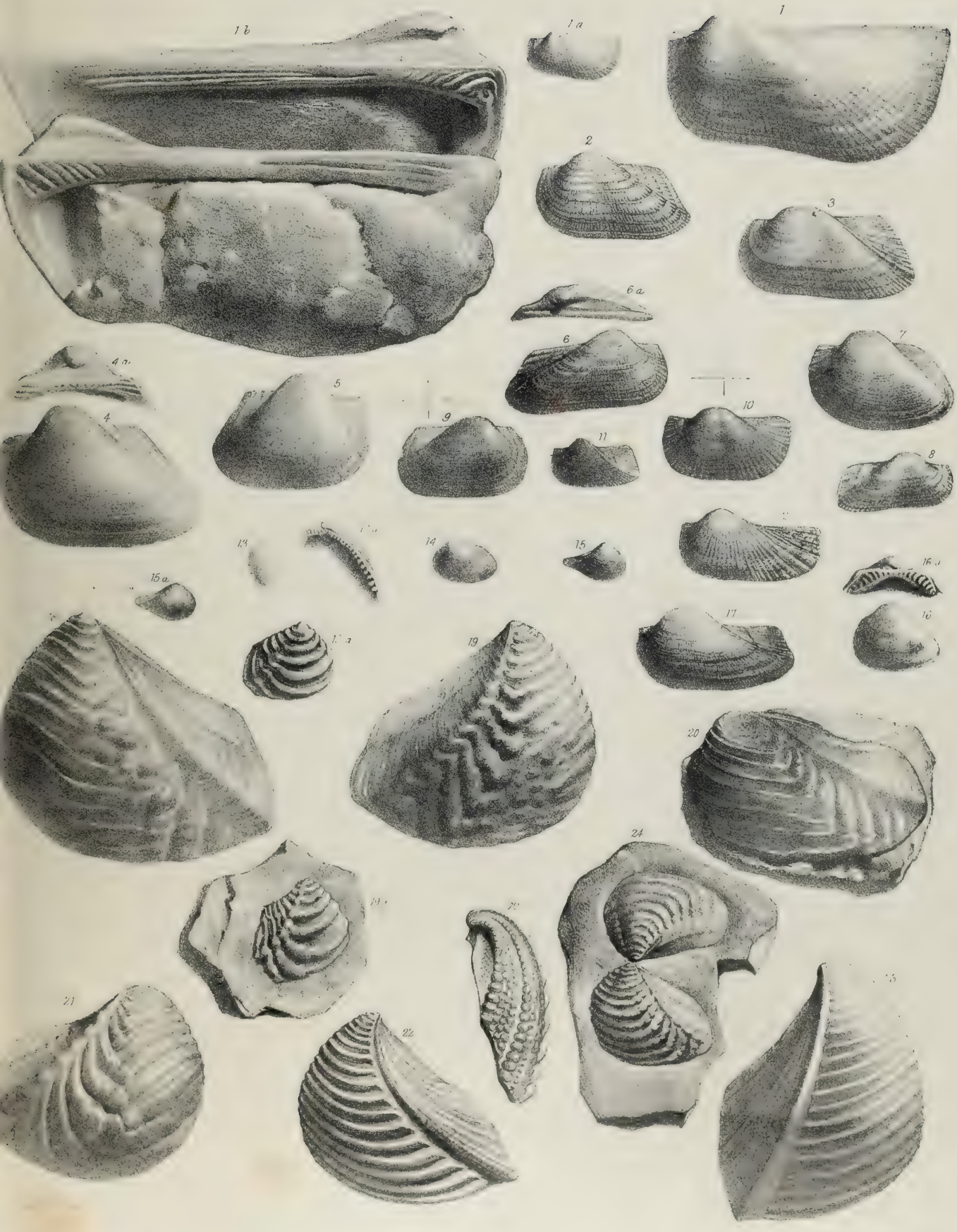
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4 a
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Lel a mucra
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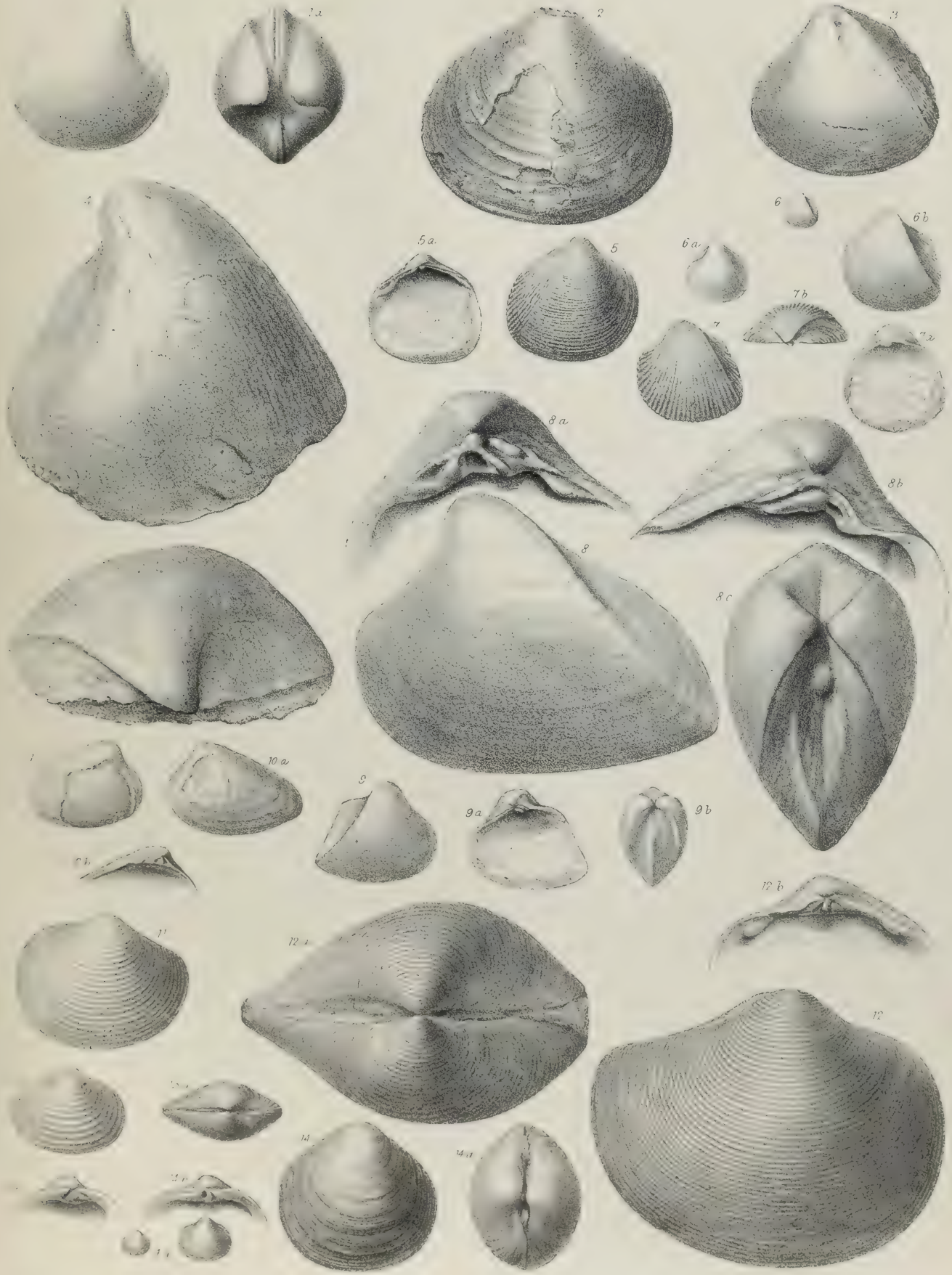

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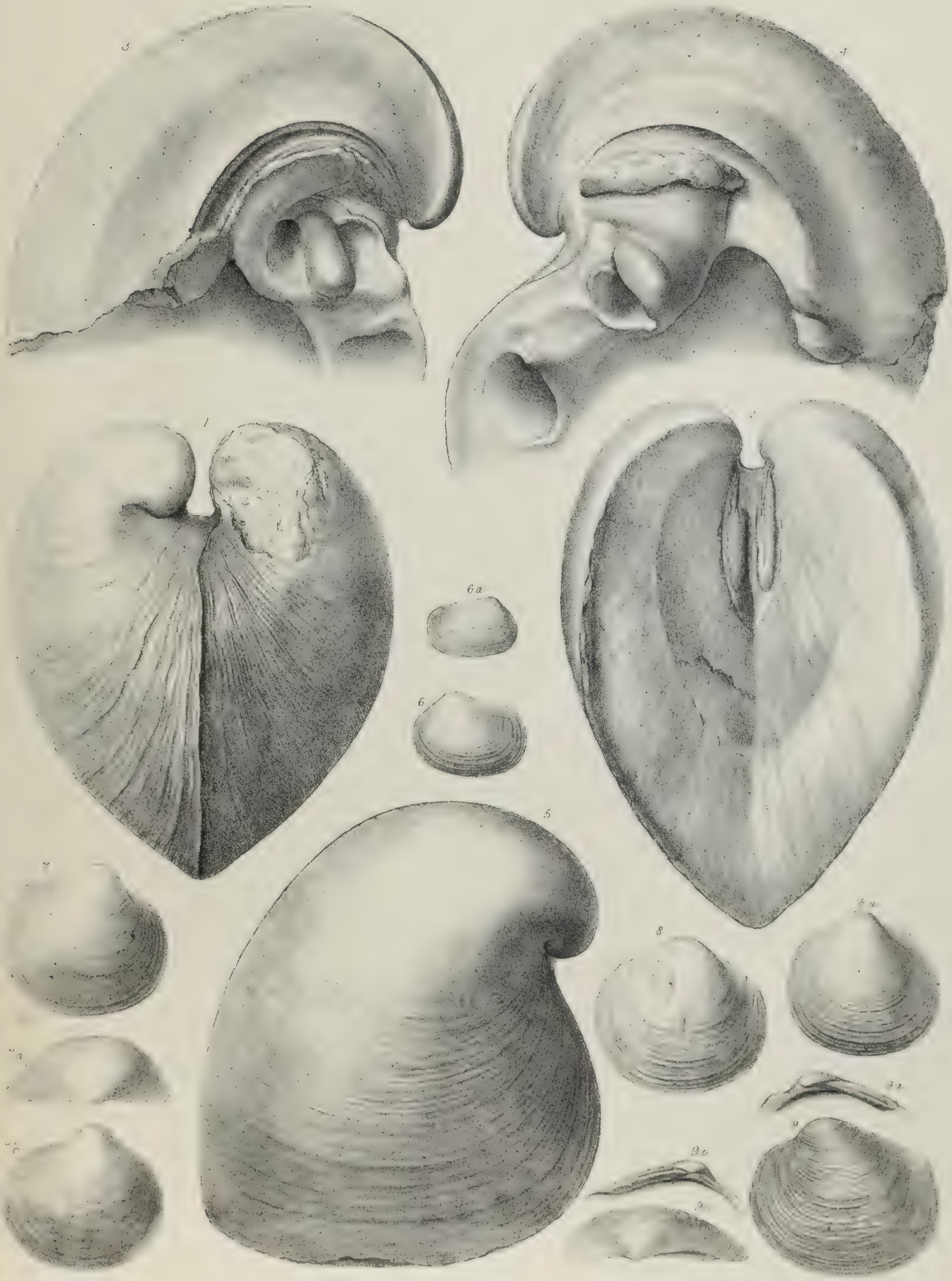

W.H. Baily, del. et lith.

To the Subscribers.

An earnest desire was expressed at the commencement of this work to make the Monograph as complete as possible, and I beg to return my best thanks to those kind friends who have so readily and obligingly assisted me with the use of their specimens for that purpose. I have now to repeat my request that if there be any species or extraordinary varieties unnoticed, amongst the Genera already described, in the Cabinets of Collectors to which I may not have had access, or which I may have overlooked, or that may have been recently discovered, if they will allow me to have them introduced into the next and concluding portion, I shall be still further obliged. We shall then have done our best to make known the 'Crag Mollusca;' and I may here state, for the information of any future investigator of the Crag Deposits, who may be desirous of verifying the types of what are herein described, that I have given my entire collection of these fossils to the British Museum.

S. V. WOOD.

March; 1853.

THE

PALÆONTOGRAPHICAL SOCIETY.

INSTITUTED MDCCCXLVII.

LONDON:

MDCCCLIII.

A MONOGRAPH

OF

THE CRAG MOLLUSCA,

OR,

DESCRIPTIONS OF SHELLS

FROM THE

MIDDLE AND UPPER TERTIARIES OF THE EAST OF ENGLAND.

BY

SEARLES V. WOOD, F.G.S.

CONTINUATION OF

BIVALVES.

LONDON:

PRINTED FOR THE PALÆONTOGRAPHICAL SOCIETY.

1853.

C. AND J. ADLARD, PRINTERS, BARTHOLOMEW CLOSE.

Cardium,* *Linnæus.*

Pectunculus. *Adanson*, 1757.
Cerastes and Cerastoderma. *Poli*, 1795.
Isocardia, (sp.) *Klein*, 1753.
Cardissa. *Megerle*, 1811.
Aphrodita. *Lea*, 1833.
Lunulacardium. *Münst.*, 1840.
Lævicardium. *Swains*, 1840.
Hemicardium. *Id.*
Acardo. *Id.*
Papyridea. *Id.*
Serripes. *Beck*, sec. *Gould.*
Monodacna (part) and Didacna. *Eichw.*, 1841.

Generic Character. Shell equivalve, sub-equilateral, more or less heart-shaped; generally closed, sometimes gaping posteriorly: usually inflated, orbicular, or ovate, costated, costæ variable, from nearly obsolete to large and prominent, sharp, round and naked, often ornamented with scales or tubercles; margin dentated or crenulated; hinge composed of two cardinal teeth in each valve, and two remote and prominent lateral teeth. Ligament external. Impression of the mantle without a sinus.

Animal of the general form of the shell, its mantle open in front, with the margins generally plain, occasionally fringed, particularly towards the posterior, and around the syphons; these are short, and slightly separated, with the margins of one or both always fringed; foot large, sub-cylindrical, and bent at nearly a right angle, possessing the form of an inflected arm or elbow-joint.

Eichwald has described some species from the Caspian sea, which he has separated into three genera, under the names of *Didacna, Monodacna,* and *Adacna*, depending for his characters upon the numerical presence, or the absence of the hinge-denticles. The animals of the latter division appear deserving of separation, being furnished with elongated syphons, and consequent indenture of the mantle mark. Some fossils also from the Palæozoic rocks, justly erected into a Genus by Professor Phillips under the name *Pleurorhynchus*, much resembled the general character of cockles, but were probably furnished with elongated syphons, as the shell is greatly produced on the posterior side. Species possessing undoubted characters of this Genus, have been obtained from the Middle Secondary Formations, and they are largely developed in the Tertiaries, while from the present seas not less than 200 species have been obtained. Their range geographically takes in nearly the whole surface of the Globe, and they are met with in Estuaries as high as low-water mark, while some are inhabitants of the sea at depths not exceeded by any other Molluscs. They generally frequent sand or sandy-mud bottom, where they often congregate in prodigious numbers.

* Etym. καρδια, the heart.

1. CARDIUM ECHINATUM, *Linnæus.* Tab. XIV, fig. 3 *a—b.*

Bonanni. Recr. Ment. et Ocul., fig. 90, 1684.
Lister. Hist. Conch., lib. iii, fig. 161, 1687.
Dale. Hist. and Antiq. of Harwich, p. 292, t. xii, fig. 6, 1730.
CARDIUM ECHINATUM. *Linn.* Syst. Nat., ed. 12, No. 79, p. 1122, 1767.
— — *Dacosta.* Brit. Conch., p. 176, t. xiv, fig. 2, 1778.
— — *Müller.* Zool. Danica, t. xiii, figs. 1 and 2, and t. xiv, figs. 1—4.
— — *Donovan.* Brit. Shells, t. 107, fig. 1, 1802.
— — *Chemn.* Conch. Cab., vol. vi, p. 165, t. xv, fig. 158.
— — *Brown.* Illust. Brit. Conch., pl. xxi, fig. 6, 1827.
— — ? *Basterot.* Bord. Foss., p. 82, 1825.
— — *Phil.* En. Moll. Sic., vol. i, p. 49, and vol. ii, p. 37.
— — *Forbes.* Ægean Invert. Rep., Brit. Assoc., p. 180, 1843.
— — *Lovén.* Ind. Moll. Scand., p. 35, 1846.
— — *Alder.* Catal. Moll. North. and Durh., p. 83, 1847.
— — *Forbes* and *Hanley.* Hist. Brit. Moll., vol. ii, p. 7, pl. xxxiii, fig. 2, and pl. N, fig. 3, 1849.
— MUCRONATUM. *Poli.* Test. Sicil., vol. i, p. 60, pl. xvii, figs. 4, 5, 1792.
— SPINOSUM. *Sowerby.* Brit. Miscel., t. xxxii.
Encyc. Method., t. 298, fig. 3.

Spec. Char. Testâ orbiculato-cordatâ, convexâ, sub-æquilaterali; anticè rotundatâ, posticè sub-quadratâ; costis 19—20 *convexis, papilliferis, interstitiis concentricè striatis.*

Shell orbicularly heart-shaped, convex, slightly inequilateral, anterior side rounded, posterior angular, or sub-quadrate; ribs 19—20, rounded and papilliform, interstices marked by concentric striæ.

Diameter, $1\frac{1}{2}$ inch.

Localities. Red Crag, Sutton.
Uddevalla.
Recent, Ægean, Mediterranean, Britain, Scandinavia.

A very few specimens only of this shell have as yet come under my observation, and those are such as have not the spines or tubercular ornaments of the ribs in a perfect condition.

The hinge is furnished with strong and prominent teeth, those called lateral are nearly equidistant from the umbo, and there is a somewhat broad and prominent fulcrum for the support of the ligament; the posterior side is truncated or angular; the bend which is at the posterior lateral tooth forms an angle of about 100°, and the lines of the ribs are distinctly visible in the interior. Upon the younger portion of the shell the tubercles are generally gone, and in the fossil that part has lost the outer portion of the shell, consequently its ornament. The spaces between the ribs, which are broad and flat, are nearly as wide as the ribs themselves; they are covered with ridges or elevated lines of growth at nearly regular distances.

The figure by Dale is, I presume, of a specimen of this species, more especially as he refers to Lister's representation of *C. echinatum*, and although in my researches

this species has been very rarely met with, it may possibly have been more abundant in that part of the Crag whence his shells were taken, but now long since washed into the sea.

C. echinatum, Dubois, 'Wolhyn. Pod.,' pl. vi, figs. 13, 14, does not appear from the figure to correspond with our shell.

2. Cardium nodosum, *Montague*. Tab. XIII, fig. 4 *a—c*.

Cardium nodosum.		*Mont.* Test. Brit., p. 81, 1803.
—	—	*Turt.* Brit. Biv., p. 186, t. xiii, fig. 8, 1822.
—	—	*Hanley.* Recent Shells. Supp., pl. xvii, fig. 44.
—	—	*Reeve.* Conch. Icon. Cardium, pl. xxii, fig. 128.
—	—	*Lovén.* Ind. Moll. Scandia, p. 36.
—	—	*Alder.* Catal. Moll. North. and Durh., p. 83, 1848.
—	—	*Forbes* and *Hanl.* Hist. Brit. Moll., vol. ii, p. 22, pl. xxxii, fig. 7, 1849.
—	discrepans?	*Brown.* Illust. Brit. Conch., pl. xxii, fig. 9, 1827.
—	scabrum.	*Phil.* En. Moll. Sic., vol. ii, p. 38, vol. xiv, p. 16, 1844.
—	—	*Hanley.* Rec. Shells. Supp., pl. xvii, fig. 43.

Spec. Char. Testâ parvâ, ovato-orbiculari, parum convexâ, sub-æquilaterali, anticè rotundatâ, posticè truncatâ; costis circa 26 *planulatis, nodulosis; interstitiis punctatis.*

Shell small, somewhat orbicular, slightly convex, a little inequilateral, anterior side rounded, posterior truncated; ribs about 26, flattened, and ornamented with tubercles; interstices narrow and punctated.

Length, $\frac{1}{2}$ an inch nearly; *height*, $\frac{3}{8}$ths do.

Locality. Cor. Crag, Sutton.

Red Crag, Sutton, Alderton, Bawdsey.

Recent, Mediterranean, Britain, Scandinaviâ.

This species is particularly abundant, more especially in the Coralline Crag, at Sutton, where the larger specimens are generally much altered by the loss of all the outer coating of the shell, and with it, of course, its tubercles; but in the younger state it may be obtained plentifully in high perfection, and in some specimens the tubercles are very deciduous, while in others they cover the entire surface. The diameter is in general greater from the anterior to the posterior side, than from the umbo to the ventral margin: it is not so in all. It may be very well distinguished by its contour, which is slightly angular on the hinder side, but less so than in *C. exiguum*. The ribs are very flat and broad, and the interspaces so narrow, that it is only occasionally the ridges or punctated surface of those furrows can be seen. On the anterior and central portion of the shell, the nodules, when remaining, are broad and obtuse, reaching across the ribs, while on the posterior side, the ribs are more convex, and only ornamented in the centre with sharper or smaller tubercles.

3. CARDIUM NODOSULUM, *S. Wood.* Tab. XIII, fig. 3 *a—c.*

CARDIUM NODOSULUM. *S. Wood.* Catalogue, 1840.

Spec. Char. Testâ minutâ, subcirculari, parum inæquilaterali, compressiusculâ, tenui; costatâ et nodosâ; costis 30 *convexis, papillosis, brevibus, et obtusis.*

Shell small, subcircular, slightly inequilateral, rather compressed, thin, costated, and nodulous; ribs about 30, convex, and studded with numerous short, obtuse papillæ.

Diameter, $\frac{3}{8}$ths of an inch.

Locality. Red Crag, Sutton.

Two or three specimens only of this shell are in my cabinet.

There are several species to which this shell bears considerable resemblance, but to no one does it appear to accord in all its characters; it must, therefore, remain for the present with the provisional name attached to it in my Catalogue. In form and general outline, it is somewhat like the figure of *C. pinnulatum*, Conrad; but from the description of that shell by Dr. Gould, 'Invert. Massach.,' p. 91, it has only twenty-six ribs, and an angular ridge on the posterior side, with other characters assigned to *nodosum*, corresponding precisely in description to that species, and in like manner differing from ours.

Card. minimum, 'Phil. En. Moll. Sic.,' also resembles it in many characters, but from his description must be distinct, as there appears a great difference in the form of the ribs, for that author speaks of his shell, p. 38, "costis 30—32, *planissimis.*"

Our shell may be more fully described as nearly equilateral, the posterior side a trifle the larger, very slightly convex, or less tumid than the generality of these small species, somewhat rounded on both sides, rather the less so posteriorly; the distinguishing character is in the ribs, which are, at least, 30, not flat, but convex, with a wide space between each, and the centre of these ribs only are covered with short, narrow, obtuse, nodules; those upon each side, more especially on the posterior, are smaller than upon the middle of the shell. The interstices between the ribs are broad, deep, concave, and smooth. *Card. suecicum* has a like number of ribs, but is not smooth between them, is more inequilateral, and has vaulted scales. *Card. papillosum*, Poli, has a less number of ribs, and is otherwise different.

4. CARDIUM STRIGILLIFERUM, *S. Wood.* Tab. XIII, fig. 5 *a—d.*

CARDIUM ELONGATUM. *S. Wood.* Catalogue, 1840.

Spec. Char. Testâ minutâ, ovatâ, transversâ, valdè inæquilaterali, tumidâ; costis 24 *elevatis, planiusculis, papilliferis, papillis squamaformibus, sulcis magnis punctatis, vel transversè imbricatis.*

Shell small, ovate, transverse, very inequilateral, tumid, with about twenty-four elevated ribs, flattened on the top, and ornamented with vaulted scales or tubercles; spaces between the ribs wide, with elevated concentric ridges.

Length, $\frac{3}{8}$ths of an inch; *height*, $\frac{2}{8}$ths of an inch.

Locality. Cor. Crag, Sutton.

This elegant species is one of the most abundant shells, though very rarely found with the valves united.

It much resembles the figure of *C. elongatum*, Turt. Judging from that alone, it was imagined to have been the same, and inserted under such name in my Catalogue. The great peculiarity of our shell is the very broad furrow, or intermediate space between the ribs, and the intersecting of these furrows by regular, sharp, elevated ridges at right angles to the ribs. It is very inequilateral, and rather tumid, with a somewhat prominent umbo; the ribs are thickly studded with elevated and vaulted scales, extending about three quarters across the depressed but not quite flattened rib; and when the specimen is in good condition, the entire surface of the rib is covered with these prominent half-tubular spines.

On the posterior portion they are more prominent and sharp, the spaces between the ribs are nearly as broad as the ribs themselves, and filled with the regular ridges, giving it a somewhat cancellated appearance; the ribs are seldom less than twenty-two or more than twenty-four in number, and these are distinctly visible within the shell.

In the very infant state of this species (fig. 5 *c*), the ribs are not more than half in number; after which, an additional one is interposed between each, so that only every other rib terminates or converges to the beak. The margin of the shell is deeply indented by the ribs, more especially on the posterior side, where they project in a somewhat ragged or jagged manner beyond the margin.

5. CARDIUM EDULE, *Linnæus*. Tab. XIV, fig. 2 *a—g*.

Lister. Hist. Conch. pl. 334, fig. 171.
Dale. Hist. and Antiq. of Harwich, p. 293, pl. xii, fig. 5. 1730.
CARDIUM EDULE. *Linn*. Syst. Nat., ed. 12, p. 1124, No. 90, 1767.
— — *Don*. Brit. Shells, vol. iv, t. 124, fig. 1, 1803.
— — *Phil*. En. Moll. Sic., vol. i, p. 52, t. iv, fig. 16.
— — *Lovén*. Ind. Moll. Scand., p. 35, 1846.
— — *Midden*. Malac. Rossic., p. 548, t. xv, figs. 10-22.
— — *Basterot*. Bord. Foss., p. 81, 1825.
— VULGARE. *Dacosta*. Brit. Conch., p. 180, pl. xi, fig. 1.
— — EDULE. *Chemn*. Conch. Cab., t. vi, p. 198, t. xix, fig. 194, 1782.
— PECTINATUM. *Desh*. 2d edit. Lam., t. vi, p. 405.
— ARCUATUM, *Reeve*. Conch. Icon. Cardium, pl. xxii, fig. 133.
— ZONATUM. *Brown*. Illust. Brit. Conch., t. xxii, fig. 8, 1827.
— TENUE. *Id*. „ „ t. xxii, fig. 4.
— CRENULATUM. *Reeve*. Conch. Icon., pl. xx, fig. 112.
— RUSTICUM. *Chemn*. Conch. Cab., t. vi, t. xix, fig. 197.
— — *Eichwald*. Fauna Caspio-Caucasia Nouv. Mem. de la Soc. Imp. des Nat. de Mosc., t. vii, t. xxxvii, figs. 24-27.
— — *Phil*. En. Moll. Sic., vol. i, t. iv, figs. 12-14.
— EDULINUM. *J. Sowerby*. Min. Conch., t. 283, fig. 3, 1821.

CARDIUM EDULINUM. *Nyst.* Coq. Foss. de Belg., p. 193, pl. xv, fig. 1, 1843.
— ANGUSTANUM. *Id.* Rech. Coq. Foss. Prov. d'Anv., p. 13, No. 49, 1835.
— OBLIQUUM. *Woodward.* Geol. of Norf., p. 43, pl. ii, fig. 19, 1833.
— CLODIENSE. *Broc.* Coq. Foss. Subap., t. xiii, fig. 3, 1814.
— GLAUCUM. *Brug.* Encyc. Meth., t. i, p. 221, No. 14.
— LAMARCKII. *Reeve.* Conch. Icon. Cardium, pl. xviii, fig. 93.
— BELTICUM. *Id.* „ „ pl. xx, fig. 113.
— EICHWALDII. *Id.* „ „ pl. xix, fig. 94.

Spec. Char. Testâ variabile, plurimùm rotundato-cordatâ, obliquâ, interdùm ovatâ, transversâ, compressiusculâ aut tumidâ, parum inæquilaterali costatâ costis 18—28 *posticè sæpè obsoletis; lineis concentricis elevatis, distantibus, asperis.*

Shell variable, for the most part roundedly heart-shaped, oblique, sometimes transversely ovate, often tumid, occasionally compressed; ribs 18—28, the posterior obsolete; concentrically rugose, with distant, dwarfish imbrications.

Length, 2 inches; *height*, $1\frac{1}{2}$.

Localities. Cor. Crag, Ramsholt (var. *rusticum*).
Red Crag, passim.
Mam. Crag, Bramerton, Thorpe, Chillesford.
Uddevalla.
Recent, Mediterranean, Finmark, Britain, Caspian.

The first indication of the existence of this species is in the Coralline Crag, from which Formation I have only one specimen, and this is of the var. called *rusticum;* its habits, however, in the living condition, are such as to confine it generally to shallow water, and to the proximity of rivers, that its presence at Ramsholt in association with species that are more purely marine, is not, perhaps, to be so much surprised at. In the Red Crag, though not one of the most abundant, it is of common occurrence, but the specimens are sometimes rubbed and worn, as if they had been much disturbed, and probably transported from a distance: this is the state in which that variety called *edulinum* by J. Sowerby, in 'Min. Conch.,' is most often found, and it is the one most common there, and may, perhaps, have been derived from the older Formation, or Coraline Crag. In the Red Crag the variations are very conspicuous; in some the diameter from the anterior to the posterior side greatly exceeds the measurement from the umbo to the ventral margin; in others it is slightly the reverse; and the number of ribs is alike variable; the character most distinguishable is the slope on the posterior side where the ribs are less prominent than upon the other parts of the shell, but this is at times very indistinct, more particularly in that variety called *clodiense* (fig. 2 *e*), which I believe to be only an aberrant form of this species.

6. Cardium angustatum, *J. Sowerby*. Tab. XIII, fig. 6 *a—c*.

Cardium angustatum.	*J. Sow.* Min. Conch. t. 283, fig. 2, 1821.
—	—	*Woodward.* Syn. Tab., p. 13, 1830.
—	—	*S. Wood.* Catalogue, 1840.

Spec. Char. Testâ transversâ, elongato-ovatâ, parùm inæquilaterali; depressiusculâ, tenui; anticè rotundatâ, inflatâ; posticè attenuatâ, compressiusculâ; costis 27—32 *depressis, planulatis, approximatis, asperis; margine ventrali recto vel coarctato.*

Shell transverse, elongato-ovate, slightly inequilateral, somewhat depressed, thin; anterior side rounded, and inflated, posterior attenuated, and compressed; ribs 27—32, depressed, flattened, approximating, roughened; ventral margin straight, or rather contracted.

Length, 1½ inch; *height*, 1 inch.

Localities. Red Crag, Sutton, Bawdsey, Ramsholt, Alderton.

This species is very abundant in one or two localities, and it does not appear to have been as yet met with in any other part of the World than in the Red Crag.

In 'Min. Conch.' above referred to, vol. iii, p. 149, it is stated to be abundant in the Crag of Norfolk, but it is not enumerated amongst the shells from near Norwich by Woodward, nor have I seen a specimen from that Formation. This species may be well determined, although occasionally it presents some difference in outward form, but the posterior side is always more or less attenuated, and the dorsal margin on that side slopes at a considerable angle from the umbo; the line of the ventral margin, also, in that half of the shell, is contracted or drawn inwards, giving it a pointed form, considerably more so than in any variety of the common cockle, from which it also differs in having a greater number of ribs, and these are flatter. The umbo is nearly equidistant from each extremity, but the posterior side is much the smaller; the marks of the ribs are very distinct half way into the interior, and in some very thin specimens they may be seen up to the umbo. Externally they are flat, broad, and striated, with a narrow space between them; they are more distinct on the anterior side and body of the shell, as in *C. edule*, becoming obsolete on the posterior slope, and where the exterior is well preserved, they show a sub-imbricated surface all over. In a part of the cliff by the river side at Ramsholt, I have found this species in situ with the valves united, where they show a very slight gape on the posterior side; the specimens are particularly thin and tender, with generally a loss of a considerable part of the exterior; in these specimens the ligament is well preserved.

7. Cardium Parkinsoni, *J. Sowerby*. Tab. XIII, fig. 7 *a—b*.

Cardium Parkinsoni.	*J. Sow.*	Min. Conch., t. xlix, 1814.
—	—	*Woodward.* Syn. Table Brit. Foss., p. 43, 1830.
—	—	*Id.* Geol. of Norf., p. 43, t. ii, fig. 18, 1833.
—	—	*Nyst.* Rech. Coq. Foss. Prov. d'Anv., p. 12, No. 48, 1835.
—	—	*Potiez* and *Mich.* Cat. des Moll. de Douai, t. xi, p. 183, 1844.
—	—	*Nyst.* Coq. Foss. de Belg., p. 186, pl. xiv, fig. 2 *a*, *b*, 1844.

Spec. Char. Testâ magnâ, rotundato-ovatâ, vel oblique-cordatâ, convexâ, sub-æquilaterali; anticè rotundatâ, posticè sub-angulatâ; costis 28—32 *planulatis, sub-imbricatis.*

Shell large, roundedly ovate, or obliquely heart-shaped, convex, sub-equilateral; anterior side rounded, posterior sub-angulated; ribs 28—32, rather flattened, and slightly imbricated.

Length, $2\frac{3}{4}$ inches; *height*, $2\frac{1}{2}$ inches.

Localities. Red Crag, Walton-on-the-Naze, Felixstow, Sutton.
Mam. Crag? Thorpe (*Woodward*).

This handsome shell appears to be restricted to the Red Crag Period, for the specimens recorded by *Woodward* were rare or fragmentary, and may have been accidental introductions, as my Norwich collecting friends do not appear to have met with it in their neighbourhood. At Walton-on-the Naze it may be procured in great abundance, and at that rich deposit the specimens are generally in a fine state of preservation; my largest does not exceed the above dimensions, but fragments indicate its having attained a magnitude of at least three inches in diameter. It somewhat resembles in general appearance *C. Islandicum*, Linn., but differs from that species in the form of its ribs; it also has a resemblance to *C. maculatum*, Gmel., *C. ventricosum*, Brug., from the bay of Campeachy, but is never so large, and seldom of such comparative dimensions, our shell being generally longer than high; it differs from *C. edule* in being less angulated or pointed, but is of a more quadrate form on the posterior side, although specimens in the young state are exceedingly difficult to be distinguished. The ribs are sometimes rounded, but more generally flattened, and are, in the best preserved specimens, distinctly striated, but I have never been able to count so many as forty, the number given as its specific character in 'Min. Conch.,' and seldom more than thirty-one; they are often regularly ornamented with dwarf ridges, or sub-imbrications, crossing the prominent parts, and they are more distant than those upon the common cockle, especially on the anterior side of the shell, where, in some specimens, they are often regular and distinctive; on the posterior side these concentric ridges are coarser and closer together; the dental characters are prominent, resembling those of *edule*, though less strongly developed, with a proportionally smaller ligamental area, and the shell is thinner, in all which characters there is a sufficient difference to entitle this to be considered as specifically distinct.

8. CARDIUM DECORTICATUM, *S. Wood.* Tab. XIV, fig. 1 *a—d.*

CARDIUM DECORTICATUM. *S. Wood.* Catalogue, 1840.
— OBLONGUM. *Nyst.* Coq. Foss. de Belg., p. 187, pl. xiv, fig. 3, 1844.
— FRAGILE? *Broc.* Conch. Foss. Subap., p. 505, t. xiii, fig. 4 *a*, *b*.

Spec. Char. Testâ orbiculato-ovatâ, obliquâ, inæquilaterali, magnâ, tumidâ, costatâ, costis 34—36*; latere postico lævigato, ad latere antico costis evanescentibus.*

Shell roundedly-ovate, oblique, inequilateral, large, somewhat tumid, costated, posterior side smooth, ribs becoming obsolete or evanescent on the anterior side.

Longitudinal diameter, 3 inches; *transverse ditto*, $2\frac{3}{4}$ inches.

Localities. Cor. Crag, Sutton, Ramsholt, Sudbourn, Gedgrave.

This handsome shell is abundant in the Coralline Crag, but it is difficult to obtain in perfection, from its extreme fragility; the specimens appear not only to have lost much of their animal matter, but the exterior of the younger portion of the shell has become eroded or decorticated down to the base of the ribs, leaving only vestiges of where they had been, while the outer or older part of the shell exhibits the true characters of its original ornament.

From the description given by M. Nyst, there is every probability that the Belgian shell is identical with our English Crag fossil, but I believe it is quite distinct from the recent *C. oblongum*, Chemn., and from the Sicilian fossil, as well as from the recent British shell, *C. Norvegicum*, and also from *C. lævigatum*, Linn.; in its much more distinct and rugose ribs, it approaches closely in that character the Sicilian fossil, differing, however, from this latter most essentially in its form.

Card. tenellum, of my Catalogue, is probably the young of this species; it differs somewhat in outline from the adult shell, having a greater diameter from the anterior to the posterior side, and it was in consequence considered distinct; but intermediate ages have been since obtained, by which it is thought a specific relationship may be maintained.

9. CARDIUM INTERRUPTUM, *S. Wood.* Tab. XIV, fig. 4 *a—b.*

Spec. Char. Testâ rotundato-triangulatâ sub-obliquâ, inæquilaterali; costis 35—40 *depressis, interruptis, ad latum posticum nullis; margine ventrali serrato.*

Shell roundedly triangular, slightly oblique, inequilateral; ribs 35—40, depressed and interrupted; posterior side smooth; ventral margin denticulated.

Length, $2\frac{1}{4}$ inches; *height*, 2 inches.

Locality. Red Crag, Sutton.

I have obtained a few specimens only of this species in perfect condition, and these are all of the left valve, but fragments are not particularly rare.

The rays upon the shell are about forty in number, strongly marked by periodical lines of growth, between which the surface is much eroded or decorticated so deep as

almost to have obliterated the radiating ridges. There appear to have been periods in the life of the animal when the margin of the shell was more than ordinarily thickened, as if the process of increase in the shell was delayed or interrupted, after which it proceeded with more slender rays until they were again thickened, or rather strengthened. This fossil strongly resembles a northern form found in the sea of Ochotsck, figured by Middendorff in his 'Russian Malacology,' t. xv, figs. 23—25, described under the name of *C. Californiense*, Desh., but it is, I believe, specifically different, as in that species (according to the figure) the posterior side is much less rounded than in our Crag fossil; the hinge also appears thicker, with a wider fulcrum for the ligament.

10. Cardium venustum, *S. Wood.* Tab. XIII, fig. 2 *a—b.*

Dale. Hist. and Antiq. of Harwich, p. 293, pl. xii, fig. 18, 1730.

Spec. Char. Testâ cordato-ovatâ, obliquâ, inæquilaterali; obsoletè costatâ, costis numerosis depressis; latere postico lævigato.

Shell ovately heartshaped, oblique, inequilateral; obsoletely costated, ribs numerous, depressed; posterior side smooth, naked.

Length, 2 inches; *height*, 2 inches.

Localities. Red Crag, Walton-on-the-Naze, Sutton.

This is one of the rarer shells of the Red Crag. Being unable satisfactorily to assign it to any known species, I am reluctantly obliged to give it a new name. The shell figured by Dale is evidently the same as ours, but I cannot, as he has done, refer it to Lister's figure, which is *C. Norvegicum;* there is a strong general resemblance, but the posterior side is too much rounded to be united with that species, and it was probably a smoother shell than *C. decorticatum* of the Coralline Crag.

11. Cardium Groenlandicum, *Chemnitz.* Tab. XIII, fig. 1 *a—d.*

Cardium Groenlandicum. *Chemn.* Conch. Cab., t. vi, p. 202, t. xix, fig. 198, 1782.
— — *Gould.* Invert. Massach., p. 92, 1841.
— — *Möller.* Ind. Moll. Groen., p. 20, 1842.
— — *Dekay.* Nat. Hist. New York Zool., p. 206, pl. xxiii, fig. 250.
— — *Reeve.* Conch. Icon. Card., pl. x, fig. 53.
— — *Middendorff.* Malacozoologia Rossica, (Mém. de l'Acad. Imp. des Sci. St. Petersb.,) p. 557, t. xvi, figs. 6—9, 1849.
— edentula. *Mont.* Test. Brit. Suppl., p. 29, 1808.
— edentulum. *G. Sow.* Genera No. 34, Cardium, fig. 2.
— anodonta. *Blainv.* Man. Malac., p. 658, 1825.
— boreale. *Reeve.* Conch. Icon., pl. xxii, fig. 131.
Mactra radiata. *Don.* Brit. Shells, vol. v, t. 161, 1803.
Aphrodita columba. *J. Lea.* Trans. Amer. Phil. Soc., vol. v, p. 110, pl. xviii, fig. 54, 1833.
Acardo. *Swains.* Treat. Malac., p. 374, 1840.
Serripes. *Beck.* Fide Gould.
Monodacna propinqua? *Eichwald.* Fauna Caspio-Caucasia, p. 275, t. xl, figs. 3, 4, 1841.
? Encyc. Method., t. 300, fig. 7.

Spec. Char. Testâ sub-cordatâ, transversâ, inæquilaterali, tenui, sub-lævigatâ; anticè rotundatâ, posticè productâ et angulatâ; costis radiantibus obsoletis, striis concentricis distantibus, margine integro.

Shell somewhat heartshaped, transverse, inequilateral, thin, and nearly smooth; anterior side rounded, posterior produced and angular; ribs or radiating lines obsolete, concentric striæ distant; ventral margin with a very gentle curve, and free from crenulations.

Length, $2\frac{3}{4}$ inches; *height*, $2\frac{1}{4}$ inches.

Localities. Red Crag, Bawdsey, Sutton.
Mam. Crag, Chillesford.
Recent, Greenland, North America, Nova Zembla.

This species is abundant in the Red Crag at Bawdsey, but is very scarce in collections, from the difficulty of obtaining a perfect specimen, the exterior being always more or less eroded, and the shell becoming very thin and fragile; the same may also be said of those found in the sandy deposit of the Mammaliferous Crag Period at Chillesford.

This species is so well marked that there is no danger of its being confounded with any other, it stands, as it were, upon the very confines of our generic limits, possessing only the rudiments of those characters by which the majority of the shells in this genus are so well distinguished, and which, indeed, are in general so prominently displayed. The costæ, if they may be so called, are, in the recent shell, but faintly visible, and traces of them are left upon the thickened edges or undecomposed portions of the fossil, most distinctly upon the anterior side; the shell has much the aspect of a *mactra*, and its surface is eroded in the same manner as in the generality of the shells of that genus from the Crag. The posterior side of our shell has a squarish outline, being obtusely angular at the extremity of the posterior lateral tooth, while the ventral margin forms with the posterior side an angle not much less than 90°, though in some of the specimens from Chillesford that side is much more pointed. The arrangement of the dental characters are those of a true Cardium, but they are like the costæ, evanescent, as if a corresponding prominence existed between the teeth and ribs: two large, ovate, and deeply-impressed muscle marks are left in my specimens, seemingly compensating in its powerful adductors for the deficiency of dental characters.

Cardium Norvegicum and *Cardium pygmæum* are given in the 'List of Clyde Fossils,' by Mr. Smith of Jordan Hill.

Genus Chama,* *Linn.*, 1758.

Globus (sp.) *Klein*, 1753.
Stola. *Browne*, 1756.
Jatronus. *Adanson*, 1757.
Macrophyllum. *Gevers*, 1766.

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* Etym. χήμη, *Aristot*, a kind of shell fish.

MACROPHYLLA. *Chemn.*, 1784.
PSILOPUS (sp.) *Poli*, 1791.
GRYPHUS. *Humph.*, 1797.
LACINIA. *Id.*
LAZARUS. *Cuvier*, 1800.
ARCINELLA. *Schum.*, 1817.

Gen. Char. Shell thick, strong, and adherent, irregular, rugose or foliated externally, inequivalve, sub-equilateral, with a distant, unequal, somewhat involute umbo. Hinge with one thick, oblique, sub-crenulated, obtuse tooth in one valve, inserted into a corresponding depression in the other. Impressions of the adductor muscles elongato-oval, that by the mantle entire, or without an inflection. Ligament external.

The figure of the animal of one species, as given by *Poli*, has the mantle open in front, with the edges slightly fringed, long, sub-cylindrical, somewhat bent: foot with a projecting heel, and two short and ciliated siphonal tubes, not extending beyond the margin of the shell.

Amongst the recent species of this genus are some whose shells are elegantly ornamented with spines or foliations, while others are rough, and possessed of but little beauty, and the rugose exterior often forms a firm attachment for species of sponge, by which they are occasionally covered.

The animal generally fixes itself by the left valve, though sometimes by the right, and specific distinctions have been formed in consequence, upon the belief that the same species always adheres by the same valve. Recent observations have proved the fallacy of this dependence.

Animals belonging to this Genus are inhabitants of tropical or sub-tropical regions, and are not known in a living state further north than the Mediterranean. It is rather a modern genus, no true species being found in any formation older than the Tertiaries.

1. CHAMA GRYPHOIDES, *Linnæus.* Tab. XV, fig. 8 *a—d.*

CONCHA RUGATA RONDELETII. *Aldrov.* De Test., lib. iii, p. 458, 1623.
GLOBUS UNDATUS. *Klein.* Tent., p. 173, No. 3, t. xii, fig. 81.
CONCHA RUPIUM. *Chemn.* Conch. Cab., t. vii, p. 145, t. li, figs. 510—513.
— GRYPHOIDES. *Gault.* Ind., part v, t. 101, lit. c—e.
CHAMA — *Linn.* Syst. Nat., ed. 12, No. 165, p. 1139, 1767.
— — *Chemn.* Conch. Cab., t. vii, t. li, figs. 510—513, 1787.
— — *Poli.* Test. Utr. Sic., vol. ii, p. 122, t. xxiii, figs. 3, 4, and 20, 1795.
— — *Broc.* Conch. Foss. Subap., p. 519, No. 2, 1814.
— — ? *Basterot.* Bord. Foss., p. 81.
— — *Bronn.* Lethæa Geogn., vol. ii, p. 927, t. xxxviii, fig. 11, 1838.
— — *Phil.* En. Moll. Sic., vol. i, p. 68, vol ii, p. 49.
— — *Savigny.* Egypt., t. xxii, p. 211, pl. xiv, figs. 8, 1—3.
— — *D'Orbigny.* Moll. de. Canar., p. 104, No. 178.

CHAMA GRYPHINA. *Lam.* Hist. des An. s. Vert., t. vi, p. 97.
— — *Goldf.* Pet. Germ., vol. ii, p. 205, t. 138, fig. 9 *a—c*.
— — *Phil.* En. Moll. Sic., vol. i, p. 68, vol. ii, p. 49.
— — *Reeve,* Conch. Icon. Chama, pl. viii, fig. 43.
— SINISTRORSA. *Chemn.* Conch. Cab., vol. ix, p. 145, t. 116, figs. 992-3, 1786.
— — *Broc.* Conch. Foss. Subap., p. 519, No. 3, 1814.
— BICORNIS. *Linn.* Syst. Nat., ed. 12, p. 1139, No. 166, 1767.
— UNICORNIS. *Desh.* 2d ed. Lamarck., t. vi, p. 582, 1835.
— — *Phil.* En. Moll. Sic., vol. i, p. 68, 1836.
— UNICORNARIA. *Lam.* Hist. des An. s. Vert., t. vi, p. 98, 1815.
— CORNUTA. *Chemn.* Conch. Cab., t. vii, p. 150, tab. lii, figs. 519-20.
— LACERNATA. *Desh.* 2d ed. Lam., t. vi, p. 588, 1835.

Spec. Char. Testâ crasssâ, irregulariter orbiculari, imbricatâ, lamellis brevibus, appressis; apice valvulæ inferioris sinistrorsum incurvo.

Shell thick, strong, irregularly orbicular, covered with short, close imbrications, or lamellæ; apex of the lower or adherent valve curving to the left.

Diameter. 2 inches.

Localities. Cor. Crag, Sutton.
Red Crag, Sutton and Newbourn.

Recent, Mediterranean.

This shell, in my cabinet, is very rare from the Coralline Crag, at the period of which deposit it was an undoubted inhabitant of our latitude; a few specimens have been found in the disturbed portion of the Red Crag, but the solidity of the shell would protect it in its possible removal from an older formation. In the few specimens that I possess from the Red Crag, a somewhat greater difference appears to exist between the two valves than is generally observable in *C. gryphoides*, or recent variety, but that is so variable a character in the living shell as to give no warrant for specific difference, depending, as it does, upon its mode of growth, or place of attachment.

The differences observable in *C. gryphina* and *gryphoides* appear to depend entirely upon the mode by which the animal chooses to attach itself, the one by the right valve, while the other is fixed by the left. In some species, as shown by Mr. Broderip, (in the 'Trans. of the Zool. Soc.,') this mode of adherence is wholly eclectic, depending upon the will of the animal, and that it almost as often employs the one valve as the other for that purpose.

In the var. *gryphina* the lower and larger valve, or that which has been the fixed one, is the right, with the umbo taking a spiral or involute direction towards the left hand, and the free valve appears more as an operculum to cover the animal, which principally occupies the lower valve, like the oyster. In *C. gryphoides* this is reversed, the left valve being made the adhering one, has consequently become the larger. Such a character is a less organic change than we find exhibited in the two opposite forms of *Trophon antiquum*, the spire of which, in the recent shell, turns commonly to the

right, while that of the fossil from the Crag, now admitted by all conchologists as only a variety, turns generally to the left. In my first examination of the recent species, there appeared a difference of form in the impressions by the adductors, which, however, further observation proved to be no permanent character; the shape of these muscle marks being considerably modified by the outward form of the shell, and like the oyster, or any other adherent species of the Bivalvia, is more subject to distortion by the position it has chosen to fix itself, than is ever partaken of by those species which are free, and the muscle marks undergo an elongation or contraction, conforming themselves, in that respect, to the varying properties of the shell, and showing that these are no more to be relied upon than are the outward forms of the shells themselves.

Cardita,* *Bruguière.* 1789.

Anomalocardia (sp.) *Klein*, 1753.
Actinobolus. *Klein*, 1753.
Limnea et Limnoderma (sp.) *Poli*, 1795.
Trapezium (sp.) *Humph.*, 1797.
Beguina. *Bolten*, 1798.
Arcturus. *Humph.*, MS.
Venericardia. *Lam.*, 1801.
Glans. *Megerle*, 1811.
Arcinella. *Oken*, 1815.
Cardissa. *Oken*, 1815.
Mytilicardia. *Blainv.*, 1824.
Carditamera. *Conrad*, 1838.
Agaria. *Gray*, 1840.

Gen. Char. Shell regular, thick, and strong, equivalve, inequilateral, suborbicular or transverse, closed, generally covered with more or less elevated, thick, and distinct costæ; hinge furnished with two teeth, one short, placed near the umbo, the other oblique, sub-marginal, prolonged towards the posterior. Impression of the mantle without a sinus, those by the adductors deeply seated. Ligament external.

Animal of the form of the shell, with the edges of the mantle disunited, and without projecting siphons; foot small and elongated: buccal opening furnished with three or four pairs of tentacles.

Shells constituting this genus are ornamented upon the exterior with ribs radiating or diverging from the umbo, and are more or less elevated, becoming in some species nearly obsolete, and the shells are always thick and strong.

In the recent state, as a Genus, it has an extended geographical range, one species being found on the Coast of Norway, while others inhabit the seas of New Holland, the Indian Ocean, China Seas, shores of Western Africa, and the East Coast of

* Etym. καρδια, the heart.

America; though not numerous in species, they are widely distributed. They are all marine, and probably, from the thickness of their shells, were inhabitants of not very deep water. The animal is said to be occasionally fixed by a byssus, though that is seldom the case, as, generally, the valves are capable of being perfectly closed.

It does not appear to be a very ancient genus, though largely developed in the Tertiaries.

1. CARDITA SENILIS, *Lamarck.* Tab. XV, fig. 1 *a—f.*

VENERICARDIA SENILIS. *Lam.* Ann. du Mus., t. vii, p. 57.
— — *Id.* Hist. des Env. de Par., p. 222.
— — *Desh.* 2d ed. Lam., Hist. des An. s. Vert., t. vi, p. 384, 1835.
— — *Parkinson.* Org. Rem., vol. iii, p. 191, pl. xiii, figs. 15, 17, 1811.
— — *J. Sow.* Min. Conch., t. 258, figs. 1—3, 1820.
— — *Nyst.* Rech. Coq. Foss. d'Anv., p. 11, No. 43, 1835.
— — *Lyell.* Trans. Geol. Soc., 2d ser., vol. v, p. 245, fig. 1, 1836.
— ANTIQUATA. *Leathes'* MS., fide J. Sowerby.
— INTERMEDIA? *Dubois.* Wolh. Podol., p. 61, pl. v. figs. 20-1, 1831.
CARDITA SQUAMULOSA. *Nyst.* Coq. Foss. de Belg., p. 207, pl. xvi, fig. 4 *b*, and fig. 5 *a*, *b*, 1844.
Dale. Hist. and Antiq. of Harw., p. 291, t. xii, fig. 4, 1730.

Spec. Char. Testâ obliquè-cordatâ, inæquilaterali, oblongâ, sub-quadratâ vel orbiculari; compressâ vel turgidâ, crassâ, clausâ; costis 17—20 *magnis, convexis, rugosis, interdùm squamis, elevatis, fornicatis, asperis; lunulâ parvâ, impressâ, dentibus crassis, perpendiculariter striatis.*

Shell obliquely heartshaped, inequilateral, oblong, subquadrate, or orbicular, tumid or compressed, thick, strong, and closed, furnished with 17—20 large, convex, rugose costæ, sometimes ornamented with distant, arched, and elevated squamæ; lunule small, deeply impressed, teeth thick, and striated in a vertical direction.

Largest Diameter, $1\frac{3}{4}$ inches.

Localities. Cor. Crag, Ramsholt, Sutton, Sudbourne, and Gedgrave.
Red Crag, Sutton, Newbourn, Alderton, Bawdsey, Felixstow.

At Gedgrave it may be procured by hundreds, and occasionally with the valves united, when it forms one of our handsomest shells. It appears to have flourished in great profusion during the period of the Coralline Crag; and from the large number of specimens met with in the Red Crag, it may probably have extended its existence into the period of that deposit, although I have not yet found it at Walton-on-the-Naze.*

This is also one of the most variable of the whole class of Bivalves. The shell with this name, as given from the Environs of Paris by Lamarck, is probably an error, at least I have not been able to see an Eocene species with which it could be identified;

* Dale gives it from Harwich, but as a shell of rare occurrence.

the fossil from Angers is, in all probability, the same, as I have no doubt the one figured and described by M. Nyst (*C. squamulosa*) is no more than a variety of this Protean shell. The valves are always very thick and strong, ornamented with rounded radiating ribs; these are covered with more or less rugose lines of growth at all times, and in some well-preserved specimens large and elevated squamæ may be observed at somewhat irregular distances; the spaces between the ribs, upon the centre and anterior part of the shell, are rather narrower than the ribs themselves, more especially on the posterior part, where they are also less elevated. The umbones are slightly involute, and have a small plain space or lunule immediately beneath them. The right valve has one large tooth sloping towards the posterior side, with the rudiments of a small one before it, near the umbo; in the left valve is a large depression for the tooth of the opposite one, and a thin, linear, compressed tooth, nearly parallel to the dorsal margin, with a small triangularly-formed cardinal tooth, that becomes obsolete in some specimens: these elongated teeth are marked with vertical striæ like the lateral teeth in some species of *Mactræ*, *Cyrenæ*, &c.

In those species with a very transverse form of valve, the shell is generally more compressed, and *vice versâ*, in the orbicular varieties it is more tumid; deep impressions are left by the adductors, and the margin of the shell is indented by the elevation of the ribs; a small additional muscle mark is left upon the shell joining the anterior adductor, such as is common to most of the species of *Astarte* and some of the *Veneridæ*, and the ligament was probably strong and powerful, as indicated by the fulcrum, and deeply impressed furrow on the outside.

In all my specimens, notwithstanding its extreme range in variation in regard to form, from that which is truly orbicular and nearly equilateral, to those which are more especially transverse and very inequilateral, they invariably possess the character of being somewhat rounded at the posterior side, and never angulated, like *Ch. antiquata*, Linn. I am not sufficiently acquainted with the Italian fossils to say whether either of the shells figured by *Brocchi* could be united with the Crag shell, but those specimens I have seen appear to differ in being also less rounded on the posterior side, with a slight difference in the form of the ribs, and covered with more prominent scales.

2 CARDITA SCALARIS, *Leathes'* MSS. Tab. XV, fig. 5.

VENERICARDIA SCALARIS.		*J. Sowerby*. Min. Conch., t. 490, fig. 3, 1825.
—	—	*Nyst*. Rech. Coq. Prov. d'Anv., p. 12, No. 47, 1835.
—	—	*Potiez et Mich*. Catal. des Moll. de Douai, p. 166, No. 19, 1844.
CARDITA	—	*Goldf*. Pet. Germ., vol. ii, p. 188, t. 134, fig. 2 *a*, *b*.
—	—	*Nyst*. Coq. Foss. de Belg., p. 213, pl. xvi, fig. 9 *a*, *b*, *d*, 1844.

Spec. Char. Testâ orbiculato-triangulari, depressâ; costis 20—22 *convexis, nodosis; concentricè sulcatis; umbonibus medianis.*

Shell triangularly orbicular, depressed, with 20 to 22 convex, close set nodulous ribs; concentrically sulcated; umbones moderately elevated.

Diameter, $\frac{1}{2}$ an inch.

Localities. Cor. Crag, Sutton, Sudbourn, and Gedgrave.
Red Crag, Sutton, Walton-on-the-Naze.

This species is very abundant in the Coralline Crag at Gedgrave and Sudbourn, and it is by no means scarce in some parts of the Red Crag. The most distinguishing character in this shell is the nodulous form of the ribs, which are placed near together, separated only by a narrow line. The outline of this shell is in general pretty regular, being of a roundly trigonal form, with the umbo turning slightly towards the anterior; occasionally the umbo is more elevated, giving it then a thicker hinge; a small smooth space or lunule is visible, when perfect, on the anterior side, and the elevated ribs produce a deeply crenulated margin.

3. Cardita orbicularis. *Leathes'* MS. Tab. XV, fig. 4.

Venericardia orbicularis. *J. Sowerby*. Min. Conch., t. 490, fig. 3, 1825.
— — *Potiez et Mich.* Cat. des Moll. de Douai, p. 165, No. 17, 1844.
Cardita — *Nyst*. Coq. Foss. de Belg., p. 214, pl. xvi, fig. 10 *a*, *b*, *d*, 1844.
— tuberculata. *Goldf.* Pet. Germ., vol. ii, p. 188, t. 134, fig. 3 *a*, *b*.

Spec. Char. Testâ orbiculari, tumidâ, convexâ, crassâ; costis 16—18 *distantibus; concentricè sulcatis.*

Shell orbicular, convex, tumid, and thick; 16 to 18 convex ribs, with a flat space between them; concentrically sulcated.

Diameter, $\frac{1}{2}$ an inch.

Localities. Cor. Crag, Sutton.
Red Crag, Sutton, Newbourn.

This species is also abundant both in the Coralline and in parts of the Red Crag, but I have not seen it from Walton-on-the-Naze. The shell is more orbicular than the preceding, and it is also more tumid; the costæ are different, being narrower and standing apart, having a flat space between them, equal to the breadth of the ribs; the costæ are ornamented with nodules like those of *scalaris*, but are fewer in number; the interstices show the obtuse lines of increase, but they are not elevated like those upon the ribs, and the umbo is rather more curved and less prominent.

4. Cardita chamæformis, *Leathes'* MS. Tab. XV, fig. 3 *a*—*b*.

Venericardia chamæformis. *J. Sow.* Min. Conch., t. 490, fig. 1, 1825.
— — *Potiez et Mich.* Cat. des Moll. de Douai, p. 162, No. 3, 1844.
Cardita chamæformis. *Goldf.* Pet. Germ., vol. ii, p. 189, t. 134. fig. 4 *a*, *b*.
— — *Nyst*. Coq. Foss. de Belg., p. 211, pl. xvi, fig. 7 *a*, *b*, *d*, 1844.

Spec. Char. Testâ suborbiculari, convexiusculâ, crassâ; costis 14—16 *convexis, rugosis; natibus prominentibus.*

Shell suborbicular, slightly convex, thick; with 14—16 rugose and convex ribs, umbones rather prominent.

Diameter, $\frac{1}{2}$ an inch.

Localities. Cor. Crag, Sutton.

Red Crag, Sutton, Newbourn.

This shell is not very abundant in my cabinet. It has a more elevated umbo and a less number of ribs than either of the preceding species; the form of the hinge as well as the muscle marks being the same in all, only varying a little in conformity with the varying outline of the shell. The ribs in my specimens are somewhat distant, more rounded, and less nodulous than in *C. scalaris*, less distant than in *C. orbicularis*.

5. Cardita analis? *Phil.* Tab. XV, fig. 6.

Cardita analis. *Phil.* Palæont. Beitr., p. 50, t. vii, fig. 6 *a—c.*
(?) — Dunkeri. *Id.* „ „ t. vii, fig. 7, *a—c.*

Spec. Char. Testâ suborbiculari, depressiusculâ, costis circa 20 *convexis, rugosis vel subtuberculatis; natibus prominentibus.*

Shell suborbicular, slightly depressed, with about 20 convex, rugose, or obsoletely tuberculated costæ; umbones prominent.

Diameter, $\frac{5}{8}$ths of an inch.

Locality. Mam. Crag, Bridlington.

This species appears to be peculiar to the more recent Formation at Bridlington, differing in some degree from all my Red or Coralline Crag specimens of this genus, in having the depressed form of rib, and resembling in that character *C. chamæformis;* but they are more numerous, being from 20 to 24 in number, and somewhat nodulous, more especially in the young state; they are not so prominent or distinct, the concentric striæ being more numerous, and not deeply impressed, so as to separate the shell into nodules, and there appears also to be a larger anterior muscle mark, extending more into the shell; my series of this species is not very extensive, and I am unable to say if these characters be permanent.

6. Cardita corbis, *Philippi.* Tab. XV, fig. 2 *a—d.*

Cardita corbis. *Phil.* En. Moll. Sic., vol. i, p. 55, pl. iv, fig. 19, 1836.
— — *Id.* „ vol. ii, p. 41, 1844.
— — *D'Orb.* Moll. de Canar., p. 106, No. 183, 1839.
— — *Nyst.* Add. à la Faune Conch. des Terr. Tert. de Belg.; Bull. Acad. de Brux., t. ix, p. 444, No. 34, 1842.
— — *Nyst.* Coq. Foss. de Belg., p. 216, pl. xi, fig. 9, 1844.
— — *Forbes.* Geol. Survey, vol. i, p. 415, 1846.

CARDITA NUCULINA. *Dujard.* Mém. de la Soc. Géol. de France, t. ii, part ii, p. 265, t. xviii, fig. 13 *a—f*, 1837.

— EXIGUA. *Id.*, p. 265, t. xviii, fig. 17 *a—b*.

MINUTA. *Sacchi.* Catal. Conch. Reg. Neap., p. 4, figs. 5, 6, 1836.

VENERICARDIA CORBIS. *S. Wood.* Catalogue, 1840.

— ANCEPS, var. *Id.*

Spec. Char. Testâ minutâ, ovatâ vel trigonulâ, obliquâ, crassâ; apicibus acutis; striis concentricis, densis, undulatis; sulcis radiantibus, obsoletis.

Shell small, ovate, or subtriangular, oblique, thick and strong; concentric striæ or ridges thick and undulating; radiating sulci obsolete.

Diameter, $\frac{1}{4}$ of an inch.

Localities. Cor. Crag, Sutton.

Red Crag, Walton-on-the Naze.

This is one of the commonest shells in the Coralline Crag at Sutton, and the two valves are often found united. Among the numerous specimens that are in my cabinet, the two forms figured by Dujardin from the Touraine beds may be distinguished. In that variety which has the greatest diameter from the umbo to the ventral margin, (which appears to be the one now living in the Mediterranean, as given by Philippi,) the shell is most ventricose, the umbo most prominent, and the concentric ridges much more elevated and distinct, than those are which have more distinct radiations from the umbo; in the other extreme form of variation which I had called *anceps* (*exigua*, Dujard.), the shell is more compressed, with a greater proportional diameter from the anterior to the posterior side, and the radiating ridges are more visible to the naked eye, and this variety appears to have attained rather larger dimensions, measuring as much as $\frac{5}{16}$ths of an inch. In what may, perhaps, be called the normal form (*Nuculina*, Dujard.), the exterior is covered with concentric ridges at rather unequal distances, and in the young state, or at the umbo, they are very wide apart; they appear to undulate, or are made uneven by the rays which cross them, but the rays fade away so imperceptibly into those in which they are obsolete, that I am unable to draw a line between the two. Our shell possesses one large tooth in the right valve, of a somewhat triangular form, stretching out towards the posterior, and in the other valve there are two teeth, one smaller, immediately beneath the umbo, of a triangular shape, the other compressed and elongated, sloping posteriorly, and nearly parallel to the dorsal margin; the muscle marks are large in comparison with the size of the shell.

Erycinella, *Conrad?* 1845.

Erycina (sp.) *Desh.*, 1825.
Goodallia. *S. Wood.*

Gen. Char. Shell trigonal, equivalve, inequilateral, thick? strong? and closed. Hinge composed of two teeth in each valve, and a triangular space between them. Lateral teeth obscure. Ligament internal. Palleal impression without a sinus.

ANIMAL UNKNOWN.

In 1822 Dr. Turton proposed a Genus of Bivalves under the name of *Goodallia*, with a diagnosis almost in the above words, having an *internal* ligament. The shell constituting the type of his genus, and, indeed, the only one that it contained, is now well known to be a true *Astarte*, and has a ligament placed externally upon a fulcrum; his name, therefore, has lost its claim to be retained.

The figure of a small shell is given by Conrad in his 'Fossils of the Medial Tertiaries of the United States,' corresponding apparently with the above characters, and described under the name of *Erycinella ovalis*, but without a generic diagnosis, and I have adopted it here upon the presumption that he has used it as one that had been fairly established.

The name was no doubt intended as a diminutive of *Erycina*, a genus in which a shell resembling *E. ovalis* has been placed by Deshayes, ('Coq. Foss. des Env. de Par.,' t. i, pl. vi, figs. 23—5.) The genus *Erycina*, as proposed by Lamarck, had included in it by himself an assemblage of heterogeneous materials, making it almost impossible to determine the species intended as the type, in consequence of which it has been pretty generally rejected, although retained by a few continental Conchologists for a group of shells closely related to *Tellina*, possessing *elongated* siphons, a genus to which our present species has no relationship, and the name *Erycinella* is consequently very inappropriate, our shell being evidently connected with *Astarte*.* Preserving, therefore, its close affinity, and retaining it still in the family of the Goddess of Beauty, it has, since its removal from *Goodallia*, remained in my Cabinet under the MS. name of *Astartella*, a name it was intended to have proposed, and to which I would now lay claim, provided no regular diagnosis has previously been given to the one Mr. Conrad has employed.

* There is also a general resemblance, and probably near relationship, with *Cardita*, as one small species of that Genus has the exterior ornamented with concentric instead of radiating ridges, and with a crenulated margin, but the hinge furniture and position of the ligament are quite different.

1. ERYCINELLA OVALIS? *Conrad.* Tab. XV, fig. 10 *a—f.*

ERYCINELLA OVALIS? *Conrad.* Foss. of the Miocene Formation of the United States, p. 74, pl. xlii, fig. 5, 1845.
GOODALLIA? PYGMÆA. *S. Wood.* Catalogue, 1840.
— ? CRENATULA. *Id.*

Spec. Char. Testâ minutâ, obliquâ, ovato-trigonulâ, inæquilaterali, tumidâ, crassâ, concentricè striatâ; posticè rotundatâ, anticè rectiusculâ; cardine bidentato; margine ventrali crenulato.

Shell minute, oblique, ovately triangular, inequilateral, tumid, thick and strong, concentrically striated; posterior side rounded, anterior nearly straight; hinge with two teeth, ventral margin crenulated.

Diameter, $\frac{1}{10}$th of an inch.

Locality. Cor. Crag, Sutton, and Gedgrave.

This little shell is particularly abundant in the Coralline Crag at Sutton; and from its prominent dental apparatus and crenulated margin, the two valves may be often obtained in their natural position, giving thus an opportunity of observing the entire margins of the shell in juxtaposition, without the slightest appearance of any fulcrum or depression into which the ligament could have been inserted, so as to have become visible externally when the valves are closed, the two pieces locking so close together as to be with difficulty separated. The shell is thick and strong, with a prominent obtuse umbo, and the whole exterior, when in perfect condition, is covered with concentric ridges or rounded striæ. The hinge of the right valve consists of two large teeth diverging from the umbo, having a triangular space between them, and a small obscure lateral tooth on both sides; in the left valve there are two large cardinal teeth also diverging, which lock into depressions on the *outside* of the teeth of the right valve; besides these two cardinal teeth in each there are two small denticles in the left, between which and the larger teeth are spaces for the reception of the two large teeth of the right valve, thus leaving in the centre a vacant space immediately beneath the umbo, where it is presumed the ligament was inserted; and in this valve also are two lateral teeth, the one at the extremity of the slope of the anterior margin is prominent, fitting into a corresponding depression in the anterior margin of the right valve, while on the other side it is the reverse, corresponding in this character with the lateral teeth of the small species of *Astarte*, to which it is evidently nearly related. The edge of the margin is deeply denticulated in the adult shell, but in the immature state it is perfectly smooth; the adductor muscles are deeply impressed, large, and of an ovate form, situated near the extremity of the lateral teeth; they are connected by a simple mantlemark, without the least inflection: in the young state the teeth of the hinge are comparatively larger than when full grown, and the margin is then without crenulations; from these, with some other minor differences, it was thought to be a distinct species, but a better examination and more specimens give reason to believe it to be only the immature state.

A small shell from the Paris basin, figured by M. Deshayes, 'Coq. Foss. des Env. de Paris,' tom. i, pl. vi, figs. 22—25, much resembles ours, and I applied to that gentleman for permission to inspect one of his duplicates, and he most obligingly sent over to me, for comparison, the only two specimens he possesses, and for which I beg to express my obligation. I fully concur with him in opinion that his fossil is specifically distinct from the Crag shell: although it would have been desirable to have seen a larger series of the Eocene shell, there is still so much difference between the two, that unless a much greater amount of variation exists in the older Tertiary species than is generally observable, they may very fairly be kept specifically distinct. The Crag shell is much thicker, with a different arrangement of the dental furniture, and there are no well-marked lateral teeth in the French shell; and although the artist of the figure above referred to has given an angular and pointed outline to the base of his shell, with a row of crenulations at the margin, I could not observe either of those characters in the specimens submitted to my examination, nor are they so specially mentioned in the text; it is possible, however, they may be immature specimens, and would consequently have the margins smooth.*

ASTARTE,† *J. Sowerby.* 1816.

VENUS (spec.) *Linn.*
PERONÆA and PERONEODERMA (spec.) *Poli.*
TELLINA (spec.) *Poli.*
MACTRA (spec.) *Mont.*
CYPRINA (spec.) *Turt.*
TRIDONTA. *Schum.*, 1817.
CRASSINA. *Lam.*, 1818.
CYPRICARDIA (sp.) *Id.*
NICANIA. *Leach*, 1819.
GOODALLIA. *Turt.*, 1822.
MACTROIDEA. } *Brown*, 1827.
MACTRINA. }
OREADA. } *Roullier*, 1846.
PUSCHIA. }

* Since the above had gone to press Sir Charles Lyell has returned from America, whence he had kindly undertaken to procure for me, if possible, a specimen of the Transatlantic species for examination, and in a letter received by him from Mr. Conrad the following observation occurs, which I have the permission of Sir Charles to publish.

"I have examined the shell sent by Mr. Wood, and have compared it with the only specimen we have of *Erycinella ovalis*. It is a smaller shell than the latter, of a more ovate form, and proportionally narrower, still, I believe, they constitute one species. Our specimen has radiating lines, as seen through a magnifier, but this may be owing to a weathered surface. I have seen a recent shell from the Gulf of Mexico, which I think is a congener with these fossils, but I have now none to refer to."

† Etym., the Syrian name of Venus.

Gen. Char. Shell thick, strong, and capable of being perfectly closed by the animal; generally more or less inequilateral, with a slightly trigonal form, equivalved, often smooth, sometimes rigid, or deeply furrowed on the exterior; hinge with two diverging cardinal teeth in the left valve, and a trigonal space between them for the reception of a prominent tooth of the same form in the right valve, often striated; generally a lateral tooth on the anterior side beneath the lunule, and sometimes an elevated ridge or tooth inside the dorsal margin on the posterior side; two deep impressions are left upon the shell by the adductor muscles,* and the impression of the mantle is without any inflexion; ligament external.

Animal of the form of the shell; edges of the mantle plain? disunited, except at the posterior, where they form two siphonal openings, with simple orifices, and not extending beyond the shell; foot rather small, strong, and somewhat of an angular shape.

The greater number of the species of this Genus have the inner margin of the shell covered with crenulations, and their presence or absence was for a long time considered a character of sufficient importance for specific distinction, it is now well known that those appearances are not to be depended upon for such a purpose, as in *all* the species of this Genus the immature, or, at least, the young, state of the shell has its margin smooth or free from crenulations, and never, until it has attained to maturity, does it assume that character; and whenever a specimen has its margin crenulated, it may then be considered to have arrived at its full growth.

English authors have generally adopted the above name, while upon the Continent *Crassina* appears to have been more frequently employed; there is no doubt, however, that priority belongs to Mr. Sowerby, and that Lamarck's name is entitled to rank only as third in point of date.

This genus has a considerable vertical range in the living state, but it is more often found in waters of considerable depth, and the greater number of known recent species are inhabitants of the colder regions of the North.

1. Astarte triangularis, *Montague.* Tab. XVII, fig. 10 *a—d.*

Mactra triangularis. *Mont.* Test. Brit., p. 99, t. iii, fig. 5, 1803.
— minutissima. *Id.* Test. Brit. Suppl., p. 37, 1808.
Goodallia triangularis. *Turt.* Brit. Biv., p. 77, t. vi, fig. 14, 1822.
— minutissima. *Id.* „ „ t. vi, fig. 15, 1822.
Mactroidea triangularis. *Brown.* Illust. Brit. Conch. Syst. Ind., 1827.
Mactrina triangularis. *Id.*, pl. 16, fig. 25.
— minutissima. *Id.*, 2d edit., p. 108, pl. xlii, figs. 25, 26.
Astarte subtrigona. *S. Wood.* Catalogue, 1840.

* There is also in most of the species a deeply indented mark near the anterior adductor.

ASTARTE TRIANGULARIS. *Alder*. Catal. North. and Durh., p. 87, 1848.
— — *Jeffreys*. Ann. and Mag. Nat. Hist., vol. viii, p. 166.
— — *Forb.* and *Hanl.* Hist. Brit. Moll., vol. i, p. 467, pl. xxx, figs. 4, 5, 1848.
— LÆVIGATA? *Phil.* En. Moll. Sic., vol. ii, p. 30, 1844.
CRASSINA TRIANGULARIS. *Gray*. Ann. of Philos., 1825.
— MINUTISSIMA. *Id.*
— MINIMA? *Smith*. Mem. Wern. Nat. Hist. Soc., vol. viii, p. 45, 1838.

Spec. Char. Testâ minutâ, obliqua, triangulari, subæquilaterali, lævi, crassâ: posticè convexiore, margine crenulatâ; umbonibus prominentibus.

Shell minute, obliquely triangular, nearly equilateral, smooth, thick, and strong; posterior side the more convex: margin crenulate; umbones prominent.

Diameter, $\frac{1}{8}$th of an inch.

Localities. Cor. Crag, Sutton.
Red Crag, Walton-on-the-Naze.
Clyde Beds.

Recent, Mediterranean? Britain, Hebrides.

This species is very abundant in that rich Depôt of small shells, in the Coralline Crag at Sutton, and from its denticulated margin and prominent hinge teeth, the valves are often found united. There are two different forms or varieties of it, one of which is larger and more compressed, with the posterior side less rounded, corresponding precisely with the recent shell, this is comparatively rare, while the other, (which, from its greater difference in being smaller, longer, that is with a greater comparative diameter from the anterior to the posterior margin, more tumid, and more rounded on the posterior side, was thought to be a different species, and named *subtrigona* in my Catalogue,) may be procured in large numbers. Until lately this shell was regarded as a very rare species in the recent state, and is said now to be more plentiful in the seas of North Britain than in the South, and the difficulty of obtaining a good series for comparison in 1840, induced the belief of its distinction for the Crag shell. The variety *subtrigona*, the common Crag shell, is roundedly triangular, having a diameter quite as large, occasionally even more so when measured from one side to the other, than from the umbo to the ventral margin, but in the other variety it is quite the reverse; the exterior is quite smooth, and the margin of the adult shell is crenulated on the inside, with about two dozen obtuse denticulations. In all cases the young specimens have the margins smooth, but there are others which have attained their full magnitude, with the edge quite free from crenulations; most of my specimens are colourless, but some few have the reddish brown, with which the recent shell is tinged only partially removed, leaving, as it were concentric bands of this colouring matter. The ligament of this species is placed upon a somewhat prominent fulcrum, readily distinguished externally when the valves are united, and not even partially covered by an extension of the dorsal edge.

2. ASTARTE PARVULA, *S. Wood.* Tab. XVII, fig. 11 *a—b.*

ASTARTE PARVULA. *S. Wood.* Catalogue, 1840.

Spec. Char. Testâ minimâ, obliquâ, ovato-triangulari, inæquilaterali, compressiusculâ, sublævi; posticè latiore: anticè longiore, et productiore; margine integerrimo.

Shell minute, oblique, of a triangularly ovate form, inequilateral, somewhat compressed, nearly smooth; posterior side very short and broad, anterior produced and elongated; margin smooth.

Length, $\frac{1}{9}$th of an inch; *height*, $\frac{1}{10}$th ditto.

Locality. Cor. Crag, Sutton.

This is also an abundant shell at Sutton, but rarely obtained with the valves united. It is a true *Astarte*, and may be distinguished from the preceding, which is the species it most resembles, and for the young of which, without care, it might be mistaken; its differences are principally in outline, this being much more inequilateral, and in place of having the form of an imperfect equilateral triangle, like that of *A. triangularis*, the lines of the margins form with the umbo nearly a right angle; the posterior side is particularly short, with a very gentle curve to the ventral margin, while the anterior is very much produced, sloping in a straight line to within a short distance of the extremity, considerably reducing the breadth, or rather height, of that side; the hinge is furnished with one large triangular tooth in the right valve, as in all the species of the genus, with two in the left, and the prominent marginal or lateral tooth of the right valve, which fits into a corresponding depression in the left, is on the posterior side, while on the anterior side of the umbo, the elevated ridge is in the left valve, and at a considerable distance; the exterior is generally smooth, but in perfect specimens, obsolete, concentric ridges, though not very regular, may be detected.

The shell in its recent state was probably of a reddish-brown colour, like the preceding species, traces of which remain in some specimens, and in others it is also formed into concentric bands. The margin in all my specimens is free from the least appearance of crenulations, as well in those which are the largest, and presumed to be full grown, as in the smaller and consequently younger.

3. ASTARTE BOREALIS, *Chemnitz.* Tab. XVI, fig. 3 *a—d.*

VENUS BOREALIS. *Chem.* Conch. Cab. vii, t. xxxix, fig. 412, 1784.
— COMPRESSA. *Mont.* Test. Brit. Suppl., p. 43, t. xxvi, fig. 1, (large fig.) 1808.
— SULCATA. *Mat.* and *Rack.* Linn. Trans., vol. viii, p. 81, t. ii, fig. 2, 1807.
ASTARTE PLANA. *J. Sow.* Min. Conch., t. 179, fig. 2, 1817, (not Nyst.)
— — *Id.* Geol. Norf., p. 43, t. ii, fig. 14, 1833.
— BOREALIS. *S. Wood*, Catalogue, 1840.
— — *Phil.* Neuer. Conch., vol. ii, p. 58, *Astarte*, pl. i, fig. 11.

ASTARTE BOREALIS. *Forbes.* Mem. Geol. Surv., vol. i, p. 413, 1846.
— COMPRESSA. *Macgill.* Moll. Aberd., p. 261, 1843.
— — *Thorpe.* Brit. Mar. Conch., p. 247, 1844.
— CYPRINOIDES. *Duval.* Révue Zool. Cuv. Soc., p. 278, 1841.
— — *Hanley.* Recent Shells, Suppl., pl. xiv, fig. 40.
— CORRUGATA. *Loven.* Ind. Moll. Scand., p. 37, 1846.
— — *Middendorff.* Mém. de l'Acad. Imp. St. Petersb., p. 562, t. xvii, figs. 4—10, 1849.
— ARCTICA. *Moller.* Ind. Moll. Groenl., p. 19, 1842.
— — *Forb.* and *Hanl.* Hist. Brit. Moll., vol. i, p. 461, pl. xxx, fig. 7, 1848.
— LACTEA. *Brod.* and *Sow.* Zool. Journ., vol. iv, p. 365, 1829.
— — *Gray.* App. to Beechey's Voy. Zool., p. 152, t. xliv, fig. 19, 1839.
— SEMISULCATA. *Gray.* List Brit. Moll., p. 92, 1851.
CRASSINA ARCTICA. *Gray.* Append. to Parry's Voyage.
— — *Hanley.* Recent Shells, vol. i, p. 88.
— BOREALIS. *Nilson.* Nov. Act. Holm., p. 188, pl. ii, figs. 3, 4, 1822.
— COMPRESSA. *Brown.* Illust. Brit. Conch., pl. xviii, figs. 4, 5, 1827.
— CORRUGATA. *Id.* „ „ pl. xvi, fig. 4 „
— WITHAMI. *Smith* and *Brown.* Mem. Wern. Soc., vol. viii, p. 57, pl. i, figs. 24, 25, 1838.
— SEMISULCATA. *Leach,* in Ross's Voy., Append., p. 175, 1819, (fide Gray.)
TRIDONTA BOREALIS. *Schum.* Essai d'un Nouv. Syst. des Hab. des Vers. Test., p. 146, pl. xvii, fig. 1 *a—b*, 1817.

Spec Char. Testâ crassâ, cordato-trigonâ, inæquilaterali, posticè longiore, subcompressâ, lunulâ elongatâ, profundè excavatâ; margine integerrimo.

Shell thick, somewhat triangularly heartshaped, slightly compressed, inequilateral, posterior side the longer; a deep and elongated lunule; margin smooth.

Length, 1½ inch; *height,* 1¼ inch.

Localities. Mam. Crag, Bramerton, Bridlington.
Clyde Beds, Opslo, Uddevalla.
Recent Arctic Seas, Britain, Nova Zembla, Behring Straits, (*Middendorf.*)

This appears to be comparatively a modern species. In its living state it is decidedly a Boreal shell, although it is occasionally obtained alive in our own seas. As a fossil it is not at all rare in this country, either from Norwich or from the Clyde beds. Like most of the species of this genus, it is subject to considerable variation, not only in its outward form but in the markings of its exterior.

The specimens in my Cabinet from near Norwich, are generally uniform in shape, and when not decomposed, the outside is nearly smooth, with scarcely the appearance of ridges, but in the Bridlington shells, a very material difference is exhibited, even in the few specimens that I possess. The more common form is somewhat rounded, having a height only a little less than the length, but that which has been called *A. Withami* is not only comparatively much longer, but has the posterior side sloped off to a rounded point (fig. 2 *c*, *d*), and this has the umbo covered with distinct ridges extending over a fourth of the exterior, while the one from Norwich is in that part

smooth. In the recent state it is covered with a thick, olivaceous, or dark coloured epidermis, and at the umbones the shell is often eroded; marks of erosion are visible also, more or less, in most of the fossils.* Old specimens are generally thickened within, showing deeply-indented muscle marks. There is a deeply-excavated lunule on the anterior side, and a corresponding slope on the posterior dorsal margin, with a prominent fulcrum for the ligament.

It is said to be obtained in deep water in the British seas, though probably it had an extensive vertical range, being found as a fossil at Bramerton, in association with *Littorina littorea*, *Mytilus edulis*, and others that now inhabit very shallow water; and the fossil specimens are in that good state of preservation to justify the supposition that they had not been transported from any great distance.

4. Astarte Basterotii, *Lajonkaire*. Tab. XVII, fig. 2 *a—d*.

Astarte Basterotii. *Lajonk.* Not. Geol. env. d'Anv. (Mém. de la Soc. d'Hist. Nat. de Par.), t. i, p. 129, pl. vi, fig. 3 *a—c*, 1823.
— — *Nyst.* Rech. Coq. Foss. d'Anv., p. 7, No. 26, 1835.
— — *Id.* Coq. Foss. de Belg., p. 151, pl. viii, fig. 4 *a—c*, 1844.
— nitida. *J. Sow.* Min. Conch., t. 521, fig. 2, 1826.
— — *S. Wood.* Catalogue, 1840.
Crassina nitida. *Desh.* 2d edit. Lam., t. vi, p. 258, 1835.
Dale, Hist. and Antiq. of Harwich, t. xi, figs. 12 and 14, 1730.

Spec. Char. Testâ transversâ, ovato-trigonula, sublævigatâ, anticè rotundatâ, posticè, subangulatâ; natibus tenui-sulcatis; lunulâ elongato-ovatâ; margine crenulato.

Shell transverse, ovately triangular, nearly smooth, anterior side rounded, posterior subangulated; umbones finely sulcated; lunule elongate and smooth; margin crenulated.

Length, 1$\frac{3}{8}$ths of an inch; *height*, 1$\frac{1}{8}$th ditto.

Localities. Cor. Crag, Sutton, Ramsholt, Sudbourn, Gedgrave.
Red Crag, Sutton, Bawdsey, Felixstow, Walton-on-the-Naze?

The most distinguishing character of this species is a set of fine concentric ridges covering the young shell, and occupying generally less than the fourth part of the diameter of the surface, or a little beyond the umbones of the adult, while all the other part is smooth, or at least with only visible lines of growth.†

The general size of the most common form of the Suffolk shell is an inch in length and $\frac{7}{8}$ths of an inch in height, and it has generally then a crenulated margin, but the other specimen figured (fig. 2 *c*, *d*) measures as much as an inch and $\frac{3}{8}$ths in length, with an edge perfectly smooth; they are all rather compressed, and have a deep, elongated

* A recent specimen in the possession of Mr. Lowry, with the specific name of *lactea* attached, but which I believe to be only a var. of this species, is quite free from ridges about the umbo.

† The ridges upon the umbo of the Belgian shell are somewhat larger than those upon the British specimens, and may be considered a distinct variety.

and smooth lunule, and an elongated corselet on the posterior side; there is an elevated ridge of the dorsal margin in the right valve, and a correspondent furrow on the same side in the left: the anterior lateral tooth or ridge is in the left valve, and the corresponding furrow on that side in the right; there are three teeth in the right valve, one large and two very small, with two large teeth in the left one; the large central triangularly-formed tooth is ridged or roughened on its sides, and the same may be seen in perfect specimens on the inner side of the two diverging teeth of the left valve.

5. ASTARTE INCRASSATA? *Brocchi.* Tab. XVI, fig. 6 *a*—*b*.

VENUS INCRASSATA. *Broc.* Conch. Foss. Subap., p. 557, t. xiv, fig. 7, 1814.
CRASSINA INCRASSATA. *Desh.* 2d edit. Lam., t. vi, p. 257, 1835.
ASTARTE — *Goldf.* Pet. Germ., vol. ii, p. 194, t. 135, fig. 2 *a*, *b*.
— — *Phil.* En. Moll. Sic., vol. i, p. 38, vol. ii, p. 29.
— NITIDULA. *S. Wood.* Catalogue, 1840.

Spec. Char. Testâ crassâ rotundato-triangulari, tumidulâ, subæquilaterali, posticè paullo longiore, lævi, præterquam ad apices; lunulâ ovatâ, profundâ; margine crenulato.

Shell thick, roundedly triangular, slightly inflated, subequilateral, posterior side rather the longer; smooth, except at the umbones; lunule ovate, and deep; margin crenulated.

Diameter, $\frac{3}{4}$ths of an inch.

Localities. Cor. Crag, Sutton, Sudbourn.
Red Crag, Sutton. Recent, Mediterranean?

This species is abundant in the Coralline, and it is occasionally met with in the Red Crag. Although somewhat variable as a British fossil, it is less so than many other species of this genus. It most resembles the shorter varieties of the preceding, but may be distinguished by several characters that appear to be permanent. Our Crag species has its identification in a Sicilian fossil, which is presumed to be the same as *Ast. incrassata*, Phil., and *V. incrassata*, Broc., the former of these two authors speaks of his shell as very variable in its external appearance, some, he says, are almost smooth, whilst others are sulcated almost to the margin; our Crag specimens are generally very regular in that character, and only in the region of the umbones is the shell at all ridged, and these extend only to a short distance, while all the rest of the surface is perfectly smooth. The shell as represented by Brocchi, is free from ridges of any kind, although in the text, p. 557, he says, "natibus transversim rugosis."

The general form of our shell is somewhat angulated or truncated at the posterior side, the umbones turning a little towards the anterior one, over a large and deep lunule, and on the other side is a large lanceolate corselet, within which is a considerable space that was occupied by the ligament; the umbonal region is occupied by numerous small and rounded ridges, and the margin of the adult shell is deeply crenulated.

6. ASTARTE MUTABILIS, *S. Wood.* Tab. XVI, fig. 1 *a—h.*

ASTARTE MUTABILIS. *S. Wood.* Catalogue, 1840.
— PLANATA. *Nyst,* (not Sowerby.) Rech. Coq. Foss. d'Anv., p. 7, No. 23, 1835.
— — *Id.* Coq. Foss. de Belg., p. 151, pl. vii, fig. 6 *a—b,* 1844.

Spec. Char. Testâ transversâ, oblongâ, subcordatâ, crassâ, inæquilaterali, posticè longiore, truncatâ; natibus latè sulcatis; lunulâ profundè excavatâ; lævigatâ; marginibus incrassatis, crenulatis.

Shell transversely oblong, inequilateral, slightly heartshaped, thick and strong; posterior side the longer, and truncated; umbones broadly sulcated; lunule smooth, and deeply excavated; margins thickened and crenulated.

Length, 2 inches; *height,* $1\frac{5}{8}$ths ditto.

Localities. Cor. Crag, Ramsholt, Sudbourn, Gedgrave, Sutton.
Red Crag, Sutton, Alderton, Baldersey.
Mam. Crag, Bridlington, (*Leckenby.*)

This is one of our most changeable species in this variable genus, and the two forms that have been figured are the extremes of variation, fig. *a, b,* being the most constant, may be described as the type of the species. The adult shell is particularly thick and strong, with the muscle marks deeply indented; the posterior one is large and nearly oval, the anterior one is rather less, and more straightened on the inner side, and immediately beneath the anterior lateral tooth is the third small muscular impression; the line of the mantle indicates posteriorly the short siphons of the living animal; externally the shell is nearly smooth, except at the umbones, which are nearly flat in the adult shell, with about a dozen broad and deep furrows; the umbones are generally sharp, curving over a broad and deeply-excavated lunule, with a large and elongated corselet, both of which are quite naked or smooth; in the right valve the cardinal tooth is large and projecting, somewhat rugged at the sides, with the like striations upon the inner surfaces of the two teeth in the left valve; lateral teeth obsolete; the ventral margin is nearly straight, and the posterior side somewhat quadrate. The margin of this species is quite smooth and sharp until it has attained its full size, when it becomes much thickened and deeply crenulated. Numerous specimens of the young shell may be obtained at Sutton, and I have traced them down to less than a line in diameter.

Fig. 1 *e,f* is, I presume, only an aberrant form of this species; it was obtained at Bridlington by Mr. Leckenby, to whom I am indebted for permission to have it figured.

7. Astarte Omalii, *Delajonkaire*. Tab. XVII, fig. 1 *a—f*.

Astarte Omalii. *Lajonk.* Not. Geol. env. d'Anv. (Mém. de la Soc. d'Hist. Nat. de Par.) tom. i, p. 129, pl. vi, fig. 1 *a—c*, 1823.
— — *Desh.* Ency. Meth. Vers., t. xi, p. 77, No. 2, 1830.
— — *Nyst.* Rech., Coq. Foss. d'Anv., p. 7, No. 24, 1835.
— — *Id.* Coq. foss. de Belg., pl. 152, pl. ix, fig. 2 *a, b, c*, 1844.
— rugata. *Lajonk* (not *J. Sowerby*). Loc. cit., tom. i, p. 130, pl. 6, fig. 5 *a—c*, 1823.
— — *Nyst.* Rech. Coq. Foss. d'Anv., p. 7, No. 25, 1835.
— bipartita. *J. Sow.* Min. Conch., t. 521, fig. 3, 1826.
— oblonga. *J. Sow.* Min. Conch., t. 521, fig. 4, 1826.
Crassina Omalii. *Desh.* 2d edit. Lam., t. vi, p. 258, 1835.
— bipartita. *Id.* „ „ t. vi, p. 259, 1835.
Astarte. *Lyell.* Manual of Elem. Geol., 3d edit., p. 165, fig. 149, 1850.

Spec. Char. Testâ variabile, interdùm oblongo-ovatâ sæpè trigonali; sublævigatâ aut sulcatâ, tumidâ vel compressâ, plurimùm inæquilaterali, posticè longiore, subangulatâ; lunulâ ovatâ, profundè excavatâ; natibus acutis, semper sulcatis: marginibus crenulatis.

Shell variable, sometimes ovately oblong, often trigonal, smooth or sulcated, tumid or compressed, for the most part inequilateral; posterior side the longer, subangulated; lunule ovate, deeply excavated; umbones sharp, sulcated; margin crenulated.

Length, 1$\frac{3}{8}$ths of an inch; *height*, 1$\frac{1}{8}$th ditto.

Localities. Cor. Crag, Sutton, Ramsholt, Gedgrave.
Red Crag, Sutton.

This shell is exceedingly abundant in all parts of the Coralline Crag. Of all the species of this very variable genus found in the Crag, this is, "*par excellence*," the most perplexing and difficult to determine. There is a fossil found in the Middle and Upper Tertiaries of America in which the variations in form appear even greater than in our Crag shell, as shown by a large suite of specimens in the Cabinet of Sir Charles Lyell, and that geologist, in his Paper upon the "Miocene Tertiary Strata of Maryland, Virginia, and N. and S. Carolina," published in the 'Proceedings of the Geological Society,' 1845, vol. iv, part iii, p. 555, considers *A. vicina*, *A. arata*, *A. cuneiformis*, *A. obruta*, *A. perplana*, of the American authors, to be varieties of *A. undulata*, Say., in which opinion I fully concur; but he further says, "I have some specimens of *A. bipartita* from the Suffolk Crag, which agree perfectly with the American fossil, except that in the latter the sides of the hinge teeth are much more distinctly grooved. A few only of the English specimens exhibit a faint trace of this grooving." In a species so exceedingly variable as this appears to have been in the seas of the Coralline Crag, and in the same, or at least in localities so little removed as those of Suffolk, where they are now found, it is difficult to say what effect localities so far removed as those of South Carolina might have produced upon an animal with such a tendency to variation; there is scarcely a limit to be put to its specific range, and this excessively variable character is perhaps an argument in favour of specific identification.

From the specimens of the American shell, and from the representations that I have seen, I was inclined to consider them distinct from the peculiarly angular extremity of the posterior side.

This species in the adult state has the margin thickened within and roughly crenulated, although in some large specimens this character is not seen. In all specimens the shell in its young state is covered externally with broad and deep furrows, and is much compressed, and it is in the older shell that it becomes so variable; these ridges or furrows are in some limited to a rather small space upon the surface, or what may be called the umbonal region, while in others the surface is covered with them entirely; these latter continue generally much compressed, while those which have the surface, or at least the greater part of it, quite smooth, and comparatively short, are very tumid, the lunule and corselet in that case becoming of course very large; the posterior side is always more or less truncated, and the umbo sharp, often much pointed. The rugæ spoken of by Sir Charles Lyell as so conspicuous upon the teeth, at least on the outside of the large cardinal tooth of the right valve, and the corresponding inside of the two teeth in the left valve of the American shell, are visible enough in well-preserved specimens of the English fossil, but these markings are no good specific character, and may be seen in several other species. I have traced this species down to the young shell, with a diameter little more than the eighth of an inch, when the cardinal tooth extends to the umbo, but as the shell enlarges, these teeth proceed forward, leaving a space between them; the beaks stand up prominent and sharp, but do not touch, and the opening of the valves is carried backwards by a somewhat extended ligament.

8. ASTARTE ELLIPTICA, *Brown*. Tab. XVI, fig. 7.

CRASSINA ELLIPTICA.	*Brown*.	Illust. Brit. Conch., pl. xviii, fig. 3, 1827.
— OVATA.	*Id.*	Edinb. Journ. Nat. and Geogr. Sci., vol. i, p. 12, pl. i, figs. 8, 9.
— —	*Id.*	Illust. Brit. Conch., 2d ed., p. 96, pl. xxxviii, figs. 12, 13.
— DEPRESSA.	*Id.*	„ „ p. 96, pl. xxxviii, fig. 2.
— SULCATA.	*Nilson*.	Nov. Act. Holm., p. 187, pl. ii, figs. 1, 2, fide *Forb.* and *Hanl.*
— GAIRENSIS.	*Smith*.	Mem. Wern. Soc., vol. viii, p. 42.
ASTARTE ELLIPTICA.	*Macgill*.	Moll. Aberd., p. 259, 1843.
— —	*Alder*.	Catal. Moll. North. and Durh., p. 87, 1848.
— —	*Forb.* and *Hanl.*	Hist. Brit. Moll., vol. i, p. 459, pl. xxx, fig. 8, 1848.
— GAIRENSIS.	*W. Nicol*.	MS.
— —	*Morris*.	Catal. Brit. Foss. p. 79, 1843.
— SEMISULCATA.	*Möller*.	Ind. Moll. Groenl., p. 19, 1842.
— —	*Phil.*	Neuer. Conch., vol. ii, p. 57; *Astarte*, pl. i, fig. 10.
— —	*Lovén*.	Ind. Moll. Scand., p. 37, 1846.

Spec. Char. Testâ transversâ, ellipticâ, inæquilaterali, compressiusculâ; posticè longiore, truncatâ, semisulcatâ; lunulâ profundâ, lanceolato-cordatâ; margine integerrimo.

Shell transverse, elliptical, somewhat compressed, semisulcated, inequilateral; posterior side the longer, and truncated; lunule deep, of an elongated heartshape; margin without crenulations.

Localities. Mam. Crag, Bridlington, Bramerton?
Glacial Beds of Scotland, Ireland, Wales, and North of England, (*Forbes.*)
Uddevalla. Recent, Coast of Scotland, Finmark, and Greenland.

I have seen only one specimen of this species belonging to the Mammaliferous Crag, and that is from the Cabinet of Mr. Bean, who has obligingly permitted me to have it figured, and this appears the oldest Deposit in which it is found; there is no specimen in my Cabinet from the Red Crag that can be fairly referred to this species; it is stated by Messrs. Forbes and Hanley to be particularly abundant in the more recent beds of the glacial or antihuman period. This shell is said never to have its margins crenulated, in which it differs essentially from the elliptical variety of *A. Omalii.*

In the living state it appears confined to the northern portion of our seas, extending into the colder regions of Finmark and Greenland, and is said to have a vertical range of from 10 to 40 fathoms, usually on a muddy bottom.

9. ASTARTE SULCATA, *Dacosta.* Tab. XVI, fig. 5 *a—b.*

PECTUNCULUS SULCATUS. *Dacosta.* Brit. Conch., p. 192, 1778.
VENUS BOREALIS (part). *Chemn.* Conch. Cab., t. vii, p. 26, t. xxxix, fig. 413, 1784.
— SCOTICA. *Mat.* and *Rack.* Linn. Trans., vol. viii, p. 81, t. ii, fig. 3, 1807.
— — *Mont.* Test. Brit. Suppl., p. 44, 1808.
— DANMONIA. *Id.* „ „ p. 45, t. xxix, fig. 4, 1808.
— SULCATA. *Id.* Test. Brit., p. 131, 1803.
CRASSINA DANMONIENSIS. *Brown.* Illust. Brit. Conch., pl. xviii, fig. 1, 1827.
— SCOTICA. *Turt.* Brit. Biv., p. 130, pl. xi, figs. 3, 4, 1822.
— SULCATA. *Id.* „ p. 131, pl. xi, figs. 1, 2, 1822.
CRASSINE CRASSATELLÉE. *Chenu.* Traité Elem., figs. 232, 233.
ASTARTE SCOTICA. *Flem.* Brit. Animals, p. 440, 1828.
— — *Lovén.* Ind. Moll. Scand., p. 36, 1846.
— — *Alder.* Catal. Moll. North. and Durh., p. 87, 1847.
— DANMONIENSIS. *G. Sowerby.* Gen. of Shells, figs. 1—3.
— — *Lovén.* Ind. Moll. Scand., p. 36, 1846.
— — *Middendorff.* Mém. de l'Acad. Imp. de St. Petersb., p. 560, t. xvii, fig. 3, 1849.
— SCOTICA. *Id.*, p. 560, t. xvii, figs. 1 and 2, and t. xvi, figs. 10—12.
— PALLIDA. *Jeffreys.* Conch. Mag., p. 44, 1839.
— SULCATA. *Flem.* Brit. Anim., p. 439.
— — *Forb.* and *Hanl.* Hist. Brit. Moll., vol. i, p. 452, pl. xxx, figs. 5, 6, pl. M, fig. 5.
— DANMONIÆ. *Alder.* Catal. Moll. North. and Durh., p. 86, 1847.
— OVALIS. *Woodw.* Geol. of Norf., p. 43, t. ii, fig. 15, 1833.
— ANTIQUATA? (Leathes' MSS.) *Id.*, p. 43, t. ii, fig. 16, 1833.
— VULGARIS. *Jeffreys.* Conch. Magaz., p. 44, 1839.

Spec. Char. Testâ ovato-cordatâ, sulcatâ, subæquilaterali, posticè parùm longiore, truncatâ, anticè rotundatâ; margine crenulato, vel lævigato.

Shell ovately heart-shaped, sulcated, nearly equilateral, posterior side a little the onger, anterior rounded; margin crenulated, or smooth.

Length, $\frac{5}{4}$ths of an inch; *height*, $\frac{5}{8}$ths ditto.

Localities. Red Crag, Sutton.
Mam. Crag, Bridlington (*Forbes*), Bramerton.
Clyde Beds. Recent, Britain, Finmark, North America.

As a Crag shell this is very rare; my cabinet contains a few specimens from Suffolk, and several of those are quite young, having the margin free from crenulations; the one figured is, no doubt, of this species, but differs rather from the generality of specimens now found living in the British seas, and resembles the one given by Middendorf, more especially figs. 1—3, the latter figure being probably only the mature state of the former.

10. ASTARTE COMPRESSA, *Montague.* Tab. XVI, fig. 8 *a—c.*

VENUS COMPRESSA. *Mont.* Test. Brit. Suppl., p. 43, t. xxvi, fig. 1, 1808.
— MONTACUTI. *Dillw.* Desc. Cat. Rec. Shells, p. 167, 1817.
— MONTAGUI. *W. Wood.* Ind. Testaceol., p. 34, pl. vii, fig. 19, 1825.
NICANIA BANKSII. *Leach.* Ann. of Phil., vol. xiv, p. 204, 1819.
— STRIATA. *Id.* „ vol. xiv, p. 204, 1819.
CYPRINA COMPRESSA. *Turt.* Brit. Biv., p. 136, pl. xi, figs. 22, 23, 1822.
CRASSINA STRIATA. *Brown.* Illust. Brit. Conch., pl. xviii, fig. 8, 1827.
— OBLIQUA. *Id.* „ „ pl. xviii, fig. 6, 1827.
— CONVEXIUSCULA. *Id.* „ „ pl. xviii, fig. 7, 1827.
— MULTICOSTATA. *Smith* and *Brown.* Mem. Wern. Nat. Hist. Soc., vol. viii, p. 56, pl. i, fig. 20, 1838.
— COMPRESSA. *Thorpe.* Brit. Mar. Conch., pp. 80 and 247, 1844.
— MONTAGUI. *Gray.* Ann. of Phil., 1825, p. 136.
ASTARTE ANGULATA. *Woodward.* Geol. of Norf., p. 43, t. ii, fig. 17, 1832.
— STRIATA. *Brown.* Illust., 2d ed., p. 96, pl. xxxviii, figs. 6, 7, 8.
— — *Möller.* Ind. Moll. Groenl., p. 20, 1842.
— — *Lovén.* Ind. Moll. Scand., p. 37, 1846.
— — *Gray.* Append. to Beech Voy. Zool., p. 152, t. xliv, fig. 9.
— BANKSII. *Id.* „ „ p. 38, t. xliv, fig. 9, 1842.
— — *Möller.* Ind. Moll. Groenl., p. 20, 1842.
— COMPRESSA. *Forb.* and *Hanley.* Hist. Brit. Moll., vol. i, p. 464, pl. 30, figs. 1—3, 1848.
— — *Middendorff.* Mém. de l'Acad. St. Petersb., p. 560, 1849.
— MULTICOSTATA. *Macgill.* Moll. Aberd., p. 260, 1843.
— — *Phil.* Neuer Conchyl., vol. ii, p. 59, pl. i, fig. 8.
— PULCHELLA (*Jonas*) *Phil.* Id. (fide *Middendorf.*)

Spec. Char. Testâ rotundato-trigonâ, subæquilaterali, nonnihil obliquâ, deformi, posticè latiore, sulcatâ, vel densè striatâ, margine dorsali convexiusculo, margine ventrali integerrimo.

Shell roundedly trigonal, slightly inequilateral, often somewhat oblique, and deformed; posterior side the broader or higher; dorsal margin rather rounded; externally sulcated, or covered with numerous rounded ridges; margin smooth.

Diameter, $\frac{3}{4}$ths of an inch.

Localities. Red Crag, Sutton, Alderton, Bawdsey, Walton-on-the-Naze.
Mam. Crag, Bridlington, Bramerton, Thorpe.
Clyde Beds and Uddevalla. Recent, Britain, Scandinavia.

This species is not by any means rare in the Red Crag, but the shell found there is generally that variety which has the lesser number of ridges, although amongst my specimens there is a variation from 30 to nearly 50. In the newer deposits of Bramerton and Bridlington the specimens are often nearly smooth, or have a greater number, and finer striæ, while the shells also are often somewhat deformed, with a greater comparative length, and a more quadrate kind of outline, and the apices are a little eroded.

What may be called the normal form (fig. 8 *a*) is subtrigonal, with a diameter as great from the umbo to the ventral margin as from the anterior to the posterior side, the umbo curving a little towards the anterior; the shell is generally somewhat compressed, and the ridges of the exterior are rounded and smooth, and about as broad as the spaces between them; the hinge is not very broad, and there is a somewhat prominent anterior lateral tooth at the extremity of a large and elongated lunule, and the dorsal margin is generally more or less rounded. The Red Crag furnishes specimens very variable in outline and somewhat deformed, but they are always regularly ridged and sulcated.

The recent specimens do not often exceed half an inch in diameter, and have been obtained in ten as well as in eighty fathoms.

11. Astarte crebrilirata, *S. Wood.* Tab. XVI, fig. 2 *a*—*b*.

Spec. Char. Testâ transversâ, ovato-trigonâ, inæquilaterali, tumidiusculâ, crassâ; posticè longiore, subtruncatâ; striatâ, striis crebris obtusis confertis, lunulâ elongatâ, excavatâ, margine crenulato.

Shell transverse, ovately triangular, or wedge shaped, inequilateral, slightly tumid, thick; posterior side the longer, and truncated, externally striated or ridged; striæ numerous, close, rounded, and obtuse; lunule elongated, deep; margin crenulated.

Length, $\frac{3}{4}$ths of an inch; *height*, $\frac{5}{8}$ths ditto.

Localities. Red Crag, Sutton, Walton-on-the-Naze.
Recent, Arctic Seas.

A few specimens only of what appears to be a distinct species have been obtained by myself from the Red Crag. They correspond very closely, and in such a variable genus as this, may perhaps be considered as identical with a living species in the Cabinets of Messrs. Morris and Lowry, and said by those gentlemen to have been

procured in the Arctic seas. In a comparison with the recent shell, some slight difference may be observed, the Crag one being somewhat compressed, with a rather more elevated umbo; in the two specimens belonging to Mr. Morris, there is a difference, one being less transverse than the other, and the smaller of the two has the margin of the valves deeply crenulated, while in the other it is quite smooth, and in both the umbo is much eroded, thereby considerably reducing its elevation, but in the Crag shell the umbo has not in the least been acted upon in that manner. There is a considerable resemblance with *A. gracilis* which is also found in the Red Crag, but that species is more equilateral, with the sculpture more distinct and elaborate.

12. ASTARTE GRACILIS, *Münster*. Tab. XVII, fig. 3 *a—e*.

ASTARTE GRACILIS. *Münst.* apud *Goldf.* Pet. Germ., vol. ii, p. 194, t. 135, fig. 4 *a—c*.
— PROPINQUA. *Id.* ,, vol. ii, p. 194, t. 135, fig. 3 *a—c*.
— GALEOTTI. *Nyst.* Coq. Foss. de Belg., p. 159, pl. vi, fig. 17 *a—c*.
— LIRATA. *Conrad.* Sec. Lyell Proc. Geol. Soc., 1845, p. 555.

Spec. Char. Testâ orbiculato-trigonulâ, ovatâ, transversâ, tumidâ aut compressiusculâ plurimùm subæquilaterali; lineatâ vel sulcatâ, lineis magnis convexis; margine crenulato vel integro.

Shell roundedly trigonal, ovate, transverse, tumid, or compressed, for the most part nearly equilateral, ridged or sulcated externally, with large rounded lines; margin crenulated or smooth.

Diameter, $\frac{3}{4}$ths of an inch.

Localities. Cor. Crag, Sutton, Ramsholt, Sudbourn, and Gedgrave.
Red Crag, Sutton, Bawdsey.

This species is very abundant in the Coralline, while a few specimens only, and those not in very good condition, have been found by myself in the Red Crag. The most common variety is that which corresponds with the figure by Goldfuss; this is very regular in shape, nearly equilateral, longer than high, and covered upon the exterior with about forty or fifty rounded, regularly-formed ridges, wider than the spaces between them upon the body or older part of the shell, while in the younger or in the umbonal region these ridges are somewhat sharp upon the hinder or upper side, or, as it were, obtusely reflected; the same character in regard to the ridges pervades all the varieties, and covers the entire surface, except the lunule and corselet, which are smooth; another form is more trigonal, has a thicker hinge, with a more prominent umbo, and is quite as high as it is long; var. *multilineata*, (fig. 3 *c*,) of which I have only a few specimens, varies in no other character than a greater number of these concentric ridges, amounting in these to as many as 90; the shell is very thick, tumid, and elevated, and is as high as it is long. In the full grown state the shell is crenulated at the margin, and although large specimens are often met with in which this part is quite smooth, these have not, it is presumed, attained to full maturity. It was probably

deeply coloured in its living condition, as in some specimens a tinge of this remains, and in others there are vestiges of coloured bands.

Sir Charles Lyell speaks of a fossil in the Miocene Deposits of America as allied to this species, and a specimen in my Cabinet from Savigny very closely resembles it, and is probably only a variety with the ridges rather larger, and the intermediate spaces broader.

13. Astarte incerta, *S. Wood.* Tab. XVII, fig. 4.

Astarte plana. *Nyst.* Coq. Foss. de Belg., p. 161, pl. xi, fig. 2 *a—b*, 1844.

Testâ orbiculato-ovatâ, compressâ, subinæquilaterali, regulariter striatâ; natibus prominulis; lunulâ ovatâ, lævigatâ; margine crenulato.

Shell roundedly ovate, compressed, somewhat inequilateral, regularly striated; umbo slightly prominent; lunule ovate and smooth; margin crenulated.

Length, $\frac{3}{4}$ths of an inch; *height*, $\frac{3}{4}$ths ditto.

Localities. Cor. Crag, Sutton, Gedgrave.
Belgium.

This species is not very abundant in our Crag. As it is perfectly distinct from *A. plana*, of 'Min. Conch.,' to which species the Belgian fossil was referred, and which appears to be the same as the English Crag shell, I have proposed for it a new name; it approaches very near to one of the varieties of *A. gracilis*, but the differences are such as seemingly to justify a removal. It is flatter or more compressed than any of the numerous specimens of that species that I have seen, and is more inequilateral, with a greater height. In the full grown shell, and in good condition, the margin is regularly and deeply crenulated, differing thereby most essentially from *A. plana*, as also in being covered with small and regular ridges. It is stated to be abundant in Belgium, where it has attained to rather larger dimensions.

14. Astarte crebricostata? *Forbes.* Tab. XVII, fig. 6.

Astarte crebricostata. *Forbes.* Annals Nat. Hist., vol. xix, p. 98, pl. ix, fig. 4, 1847.
— — *Jeffreys.* Ann. and Mag. of Nat. Hist., vol. xix, p. 314.
— — *Forb.* and *Hanl.* Hist. Brit. Moll., vol. i, p. 456, pl. xxx, fig. 9, 1848.
— — *Gray.* List of British Mollusca, p. 92, 1851.

Spec. Char. Testâ ovato-trigonâ, compressiusculâ, crassâ, subinæquilaterali, posticè potiùs longiore; concentricè costatâ, costis crebris obtusis, ad posticè evanescentioribus, margine crenulato.

Shell ovately trigonal, slightly compressed, thick, nearly equilateral, posterior side rather the longer, concentrically costated; ribs or ridges numerous, thick and obtuse, obsolete on the posterior part; margins crenulated.

Length, $\frac{7}{8}$ths of an inch: *height*, $\frac{6}{8}$ths ditto.

Locality. Mam. Crag, Bridlington. Recent, Britain.

One specimen only of this species has come under my observation, it was found by Mr. Leckenby, who has obligingly permitted me to have it figured.

If it were in almost any other genus than the present, the differences between this shell and the figure and description given, above referred to, might, perhaps, be sufficient to justify its being considered a new species; but with only a single specimen, I am unwilling to do more than refer it to one already established. Our present shell may be further particularised as having a prominent and sharp umbo curving a little over a lunule, large and deep; the ridges upon the exterior are large, somewhat prominent and rounded, about as wide as the spaces between them, and on the anterior side they extend up to the lunule, and there stop rather abruptly; while on the posterior side, in the young state, they reach to the edge of the corselet, becoming obsolete and nearly smooth down the slope in the older part of the shell; our specimen is more equilateral, less broad posteriorly, and of a more triangular form than the figures above referred to, but in other respects there is so great a resemblance that it may be considered as probably an aberrant form of the above species. The lunule and corselet are smooth, or, at least, show only lines of growth, and the numerous and close set ridges seem to remove it from any specific connection with *A. sulcata*.

A fossil in the Cabinet of Mr. Morris, brought from the mouth of the Varga, 200 miles up the Dwina, by Sir Roderick Murchison, more resembles the figure and description of *crebricostata* in the 'Hist. of Brit. Mollusca.'

15. Astarte pygmæa, *Münster*. Tab. XVII, fig. 7 *a*—*b*.

Astarte pygmæa. (*Münst.*) ex *Goldf.* Pet. Germ., vol. ii, p. 195, t. 135, figs. 5, 6 *a*, *b*; (excl. syn.)

— — *S. Wood*. Catalogue, 1840.

Spec. Char. Testâ minutâ, orbiculato-trigonâ, compressiusculâ, equilaterali, umbonibus prominulis; concentricè costatâ, costis crebris, convexis; margine crenato vel integro.

Shell small, roundedly trigonal, somewhat compressed, equilateral; umbones slightly prominent, concentrically costated; ridges thick, numerous, and convex; margin crenulated or smooth.

Diameter, $\frac{1}{6}$th of an inch.

Locality. Cor. Crag, Sutton.

This species is exceedingly abundant at the above locality, but the valves are rarely found united. It appears to correspond with the figure and description by Goldfuss.

Our shell has the posterior dorsal edge somewhat rounded, and the longitudinal diameter generally exceeds the height; the umbo is neither very sharp, nor very

prominent, and the exterior is covered with ridges parallel to the margin, and varying in number from 16 to 25; these are rounded and obtuse, and rather wider than the spaces between them, and in many of my specimens there are the remains of coloured bands. In the adult shell the margin is covered with about 25—30 large crenulations.

Amongst some specimens given to me by Sir Charles Lyell from Touraine, is a single valve of a shell that may probably be referred to this species, but it is not in a sufficiently perfect condition for a fair identification. Amongst a large number of specimens of our Cor. Crag shell, some may be found with the crenulated margin whose diameter does not much exceed half that of others in which such part of the shell is smooth, but the size is no argument against its having attained to a state of maturity.

Astarte Bosquetii, Nyst, 'Coq. Foss. de Belg.,' pl. vi, fig. 16, which that author has doubtingly referred to *A. pygmæa* of Goldfuss, is probably different, and may be the same as *A. circinnaria*, Mich., it is larger and more angular than our species. Some specimens of *A. minuta*, Nyst, brought home by Sir Charles Lyell, are also different, and, I think, cannot be referred to our species; the shell is smaller, more triangular; the exterior is ridged, and it has a smooth margin: neither can it, in my opinion, be referred to our British species, *A. triangularis*, nor to *A. parvula*.

16. Astarte Burtinii, *Lajonkaire.* Tab. XVII, fig. 5 *a—d.*

Astarte Burtinea. *Lajonk.* Mém. de la Soc. d'Hist. Nat. de Par., t. i, p. 129, pl. 6 *a—c*, 1823.
— — *Nyst.* Rech. Coq. Foss. Prov. d'Anv., p. 8, No. 38, 1835.
— Burtinii. *Id.* Coq. Foss. de Belg., p. 160, pl. ix, fig. 7 *a*, *b*, 1844.
— obliquata. *Id.* (not Sowerby.) Id., p. 160, pl. vii, fig. 7.
— pisiformis, var. *β*. *S. Wood.* Catalogue.

Spec. Char. Testâ crassâ, subtrigonulâ, cordiformi, tumidâ, aut compressâ, subinæquilaterali, striatâ vel sulcatâ, striis obliquis ad marginem excurrentibus; umbonibus prominulis; lunulâ magnâ, lævigatâ; margine crenulato.

Shell thick, subtrigonal, heartshaped, tumid or compressed, slightly inequilateral, striated or sulcated; striæ oblique, running out at the margin; umbones a little prominent; lunule large, deep, and smooth; margin crenulated.

Length, $\frac{7}{8}$ths of an inch; *height*, $\frac{6}{8}$ths, nearly

Length of var. *pisiformis*, $\frac{3}{8}$ths ditto; *height*, $\frac{7}{16}$ths ditto.

Localities. Cor. Crag, Sutton, Ramsholt, Sudbourn, and Gedgrave.
Red Crag, Sutton.

Very abundant in the Cor. Crag, but exceedingly scarce in the Red, so much so, that judging from my own collection, it is doubtful if true and genuine specimens have been found in it.

This shell is so excessively variable, and presents such extraordinary differences in character, that when my Catalogue was compiled, the smaller variety was considered as a distinct species, and passed under the MS. name of *pisiformis*, given to it by my friend the late Rev. G. R. Leathes, in consequence of its pea-like form, which this small variety assumes when the two valves are united; a large additional number of specimens since obtained are found to possess intermediate characters, and it is therefore thought necessary to unite the two.

The typical form may be considered as fig. 5*a*, *b*; this is a large shell, inequilateral and somewhat compressed, and slightly angular on the posterior side, and if found alone, would most deservedly be separated from the smaller and more globose variety, as two shells cannot well *appear* more distinct. The smaller variety, or *pisiformis*, has a height greater than its length, and the posterior side is nearly convex; the lunule is large and smooth, and the shape of it is modified by the form of the shell. The exterior is covered with ridges, broad and smooth, having only a narrow line between them; the ridges pass over the shell obliquely, from the edge of the corselet round to the edge of the lunule, and they take their rise on the posterior side, where they are closer and more numerous, running out or disappearing at the margin of the shell, the lines of growth, of course, crossing them at a variable angle; the number of these ridges vary according to the age or size of the specimen, the very minute not possessing more than half a dozen, while seventy may be counted in the larger and full grown individuals.

A specimen from Thorigny, given to me by Sir Charles Lyell, very much resembles our shell, and is probably only a variety.

17. Astarte obliquata, *J. Sowerby*. Tab. XVI, fig. 4 *a*—*d*.

Astarte obliquata. *J. Sow.* Min. Conch., t. 179, fig. 3, 1817.
— — *S. Wood.* Catalogue, 1840.

Spec. Char. Testâ ovatâ, transversâ, subæquilaterali, compressâ, striatâ, striis obliquis; umbonibus acutis prominulis; lunulâ lanceolatâ; margine crenulato.

Shell ovate, transverse, slightly inequilateral, compressed and striated, striæ oblique; beaks rather sharp, and somewhat prominent; an elongated lunule and margins crenulated in the adult state.

Diameter, 1¼ inch.

Localities. Red Crag, Walton-on-the-Naze, Sutton.

This shell is very abundant at the former locality; I have very rarely met with it at any other.

As far as can be determined by the figures and descriptions of the Belgian authors, it is very doubtful if this species has been found in that part of the world; the shell so called by M. Nyst appears to be only a variety of *A. Burtinii*, the species so common and so variable in the Coralline Crag.

It appears quite distinct from the preceding, in being flatter or more compressed, and the line of hinge much narrower; it is also a thinner shell. The exterior markings are much alike in both species, having somewhat flat ridges with narrow spaces between them; they pass obliquely over the shell from the posterior to the anterior side, some of which run out at the ventral margin, and cut the lines of growth at an acute angle; the hinge is composed of one large triangularly formed tooth in the right valve, with one anterior lateral tooth at the extremity of the lunule; in the left valve are two diverging cardinal teeth, with the triangular space between them, and the more distinct lateral tooth, or that which has on the outside of it a depression for the elevated edge of the opposite valve, is on the posterior side. This has also the small auxiliary muscular impression on the anterior side, and the mantle mark is without the least indentation. In the adult shell the margin is crenulated, while the younger specimens have it quite smooth. The two valves are occasionally found united in the less unmixed portion of the Red Crag Deposit at Walton-on-the-Naze.

18. ASTARTE DIGITARIA, *Linnæus*. Tab. XVII, fig. 8 *a—d*.

TELLINA DIGITARIA. *Linn.* Syst. Nat., edit. 12, p. 1120, No. 71, 1767.
— — *Chemn.* Conch. Cab. vi, p. 126, t. xii, fig. 121, 1782.
LUCINA DIGITALIS. *Lam.* Ann. sans Vert., t. v, p. 544, 1818.
— — ? *Bast.* Bord. Foss., p. 87, 1825.
— — *Phil.* En. Moll. Sic., vol. i, p. 33, t. iii, fig. 19, 1836.
— — *Id.* „ vol. ii, p. 25, 1844.
— — *Desh.* 2d edit. Lam., t. vi, p. 231, 1835.
— — *Reeve.* Conch. Icon., pl. ii, fig. 65.
— DIGITARIA. *S. Wood.* Catalogue, 1840.
— CURVIRADIATA. *Nyst.* Rech. Coq. Foss. d'Anv., p. 6, pl. i, fig. 20, 1835.
— — *Id.* Coq. Foss. de Belg., p. 137, pl. 6, fig. 12, 1844.
Ency. Method., pl. 292, fig. 5.

Spec. Char. Testâ minutâ; orbiculato-ovatâ subæquilaterali, compressiusculâ; striis obliquis incurvis, umbonibus depressis; dentibus lateralibus distinctis; margine integerrimo.

Shell small, roundedly ovate, nearly equilateral, somewhat compressed, covered with elegantly curved, oblique, impressed striæ; umbones depressed; lateral teeth distinct; margin smooth.

Diameter, $\frac{3}{8}$ths of an inch

Localities. Cor. Crag, Sutton.
Red Crag, Sutton, Walton-on-the-Naze.
Recent, Mediterranean.

Abundant in the Coralline Crag at Sutton, and by no means rare in the more genuine portion of the Red Crag at Walton-on-the-Naze, where I have found the two valves united. The only trifling difference I can detect between the British fossil and

the recent shell is that in the latter the hinge line appears rather thicker; and the same may be said of the Sicilian fossil.

In this shell the sulci or ridges take their rise, and are most numerous, like the two preceding species, on the posterior side, or that on which the ligament is placed, where they are somewhat rugose, and descend or curve in an oblique direction over the exterior or centre of the shell, and are lost or run out at different distances on the ventral margin, most conspicuously so on the anterior portion. These rugosities are regular on the posterior side, radiating in an opposite direction, like those upon the posterior side of *Venus verrucosa*, and are probably produced by the lines of growth cutting the sculpture at an acute angle; they are most distinct upon the Coralline Crag specimens.

There is a considerable variation in the outline of this species, some individuals having a height as great, or greater, than the length, but in general the larger diameter is from the anterior to the posterior margin; there is also a difference in the sculpture, the lines being much closer or more numerous in some than in others, and they are always more distant near the umbo, or on the young shell, and most distinct upon the Red Crag specimens. There are the remains of colour in some of my fossils, like concentric bands.

It was at one time thought there was sufficient difference in this species to entitle it to more than specific distinction, and it remained in my cabinet under the MS. name of *Digitaria vulgaris*, and perhaps when the animal becomes known, it may present characters that are so; but judging from the shell alone, it so strongly resembles some of the more aberrant forms of Astarte, that it seems more advisable it should be placed here, bearing, as it evidently does, a greater relationship to this genus than either to *Tellina* or *Lucina*, to which it has been hitherto referred. Unlike the former, it has the impression of the mantle entire, or without any inflection, and the impressions of the adductors are of an ovate form, the anterior one being rather the longer of the two; but unlike the latter, it wants the ligulate or band-shaped impression so characteristic of that genus. The same obliquity of ridges may be seen upon a small species with the hinge of *Cardita*, a genus probably very closely allied to the present one.

19. Astarte excurrens, *S. Wood.* Tab. XVII, fig. 9 *ab.*

Spec. Char. Testâ minimâ, transversâ, ovatâ, subæquilaterali, compressiusculâ, striatâ, striis obliquis utrinque excurrentibus; umbonibus depressis, marginibus denticulatis.

Shell small, transverse, ovate, nearly equilateral, somewhat compressed, covered with striæ that are not parallel to the margin, but run out from each side; umbones depressed; margins denticulated.

Largest diameter, $\frac{1}{6}$th of an inch.

Locality. Cor. Crag, Sutton.

This shell is not by any means rare at the above locality. It differs from the pre-

ceding species (a shell to which it seems nearest related) in several characters, being smaller, and the ridges have an oblique direction, or they are subconcentric, deviating a little from the lines of growth, so that two or three only are lost in the centre of the ventral margin, and in some specimens, more especially in those which are longer than high, this character is less distinct than in those which are more orbicular, or have a greater comparative height, where this running out of the ridges at the margin is most conspicuous. The form of the shell resembles that of *A. digitaria*, but the sculpture is different, and the margin in this, when it has attained full maturity, is furnished with rather large crenulations. In *A. digitaria* the ridges are broader and flatter than in this species, in which they are somewhat rounded. The dental characters are those of a true *Astarte*, having one triangularly-formed cardinal tooth in the right valve and two in the left, while the most conspicuous lateral tooth, or where there is a depression for the elevated edge of the opposite valve, is on the anterior side in the right valve, and on the posterior side in the left; the muscle marks also correspond with the generic character.

Some specimens of this species have also the remains of coloured bands.

20. Astarte parva, *S. Wood.* Tab. XVII, fig. 12 *ab.*

Astarte parva. *S. Wood.* Catalogue Mag. Nat. Hist., p. 249, 1840.

Spec. Char. Testâ parvâ, ovatâ, transversâ, valde inæquilaterali, posticè breviore, anticè productâ, rotundatâ; striata, striis obliquis; umbonibus acutis, prominulis; margine integerrimo.

Shell small, ovate, transverse, very inequilateral; posterior side the shorter, anterior much produced and rounded, ornamented with oblique transverse ridges not parallel to the margin; umbones sharp, somewhat prominent, and margin smooth.

Length, $\frac{1}{8}$th of an inch; *height*, a little less.

Localities. Cor. Crag, Sutton.

The sculpture differs materially in the direction the lines take in crossing the exterior from that of the preceding species, which deviate a little from the lines of growth, there being more of them upon the anterior or larger side than there are upon the posterior side, three or four running out at different parts of the margin, so that, counting from the umbo, they number more towards the anterior than on the other side; the ridges are broad and flat, separated by a depressed furrow, much narrower than the ridges, about 12 or 15 on the posterior side, with 15 to 18 upon the anterior, while the umbo or very young shell appears to have been quite smooth. The dental characters are those of true *Astarte*, with one large triangularly-shaped tooth in the right valve, and a distinct, elongated, anterior, lateral tooth at some distance; and in the left valve are two diverging cardinal teeth, with a duplicature or lateral tooth on the posterior margin; there is a somewhat thickened ridge on the posterior side, as in most of the species of this genus, within or behind which is the

impression of the posterior adductor, and the mantle mark is quite entire. In all my specimens, many of which are presumed to be full grown individuals, the margin is quite smooth, and many specimens are marked with coloured bands. There is no distinct lunule, but an elongated space on the anterior side that is quite smooth, while on the posterior side the lines run up to the margin. It is thin in the young state when the ridges are visible on the inside.

It is very abundant at the above locality, and the valves are often found united.

Isocardia,* *Lamarck.* 1799.

Bucardia. *Lister*, 1687.
Chama (spec.) *Linn.*
Glossus and Glossoderma. *Poli*, 1795.
Trapezium (sp.) *Humphr.*, 1797.
Bucardium. *Megerle*, 1811.
Diceratia? *Oken*, 1815.
Isocardium. *Blainv.*, 1824.

Generic Character. Shell equivalved, inequilateral, heartshaped, tumid, generally thick and strong, sometimes smooth, often furrowed; umbones prominent and involute. Hinge with two cardinal and one lateral tooth in each valve. Ligament external. Impression of the mantle entire, or without a sinus.

The animal of this genus is described by Malacologists as closely resembling that of *Astarte*, with a broad, short, triangularly formed foot, and the siphons not extending beyond the margins of the shell; their orifices are fringed, and the edges of the mantle double.

This genus is said to constitute a connecting link between the families of *Cyprinidæ* and the *Cockles*, and is also closely allied to *Chama* and *Diceras*, particularly in the shell, by the peculiar involution of the umbones and the recession of the ligament, by which, in its increase, the anterior portion is deserted, and its extension formed on the posterior side.

But few species are known in the living state, and at present not a large number of fossils.

1. Isocardia cor, *Linnæus.* Tab. XV, fig. 9 *a—b.*

Bucardia. *Scilla.* De Corp. Mar. Lapid., t. xvi, fig. aa, 1670.
— *Lister.* Hist. Conch., lib. iii, part ii, fig. 111, 1687.
— communis. *Schum.* Essai d'un Nouv. Syst. des Vers. Test., p. 143, pl. xiii, fig. 2 *a*, *b*, 1817.
Cardium humanum. *Linn.* Syst. Nat., ed. 10, No. 82, p. 682, 1766.
Chama cor. *Id.* ,, ed. 12, p. 1137, No. 154, 1767.

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* Etym. ἰσος, like or equal, and καρδια.

CHAMA COR. *Poli.* Test. Sic., vol. ii, p. 113, t. xxiii, fig. 1—3, 1795.
— — *Broc.* Conch. Foss. Subap., p. 519, No. 4, 1814.
CARDITA COR. *Brug.* Encyc. Meth. Vers., tom. i, p. 403, No. 1, 1792.
— — *Bosc.* Hist. Nat. des Vers., t. iii, p. 85, pl. xxi, fig. 4.
ISOCARDIA COR. *Lam.* Hist. des An. s. Vert., t. vi, p. 31, 1822.
— — *J. Sow.* Min. Conch. t. 516, fig. 2, 1826.
— — *Goldf.* Pet. Germ., vol. ii, p. 211, pl. 141, fig. 2 *a—c.*
— — *Bronn.* Leth. Geogn., p. 941, pl. xxxviii, fig. 10, 1838.
— — *Phil.* En. Moll. Sic., vol. i, p. 56, and vol. ii, p. 41.
— — *Nyst.* Coq. Foss. de Belg., p. 196, pl. xvi, fig. 1 *a, b, e,* 1844.
— — *Sysmonda.* Syn. Meth. An. Inv. Pied. Foss., p. 18, 1847.
— — *Lovén.* Ind. Moll. Scand., p. 36, 1846.
— GLOBULOSA. *Defrance.* Dict. des Sc. Nat., t. xxiv, p. 180, Atlas, figs. 2, 2 *a.*
— HIBERNICA. *Reeve.* Conch. Icon. Isocard., pl. i, fig. 4.
— VENTRICOSA. *J. Sowerby.* Min. Conch., vol. vi, p. 28.
— LUNULATA. *Nyst.* Rech. Coq. Foss. Prov. d'Anv., p. 13, pl. iii, fig. 53, 1835.
— — *Id.* Coq. Foss. de Belg., p. 189, pl. xv, fig. 2 *a—e,* 1844.
— CRASSA. *Id.* „ „ p. 198, pl. xv, fig. 3 *a—e,* 1844.
— RUSTICA. *Conrad.* Amer. Mioc. Foss., p. 20, pl. xi, fig. 1, 1838.
— FRATERNA. *Say.* Journ. Acad. Nat. Sci., vol. iv, p. 143, pl. xi, fig. 1 *a, b.*
— MARKOEI. *Conrad.* Proc. Nat. Inst., vol. i, p. 193, pl. ii, fig. 1.
— — *Id.* Amer. Mioc. Foss., p. 70, pl. xl, fig. 2, 1845.
GLOSSUS COR. *Gray.* List. Brit. Moll., p. 95, 1851.

Spec. Char. Testâ cordato-globosâ, orbiculari, tumidâ, lævigatâ, valdè inæquilaterali; umbonibus crassis, acutis, involutis et infra subexcavatis; margine ventrali integro, acuto; striis incrementi irregularibus, cardine bidentato.

Shell somewhat orbicular, or globosely heartshaped, tumid, smooth, and very inequilateral; umbones sharp, thick, and involute, beneath which the shell is depressed or subexcavated; ventral margin smooth and sharp, lines of increase irregular; hinge with two cardinal teeth in each valve.

Diameter, 2 inches.

Localities. Cor. Crag, Gedgrave, Ramsholt, Sutton.
Red Crag, Sutton.

Recent, Mediterranean, Britain, Sweden.

This species is by no means abundant even in fragments, either in the Coralline or Red Crag. The specimen figured is from Gedgrave, and seems to resemble the variety now found in the Mediterranean, being smaller and more globose, with the umbones obtuse and very prominent, while the fragments from the Red Crag, as far as they can be determined, seem to approach the form of the variety found in our own seas, in which the shell is broader, with the umbones much depressed; this character constitutes the essential difference; the more tumid variety of the Coralline Crag corresponding with the Mediterranean form, as the conditions under which each existed were probably similar, while the Red Crag shell seems more to have resembled the one now living in the British seas. Our Crag specimens may be said to be smooth, with the exception of the irregular lines of growth; the numerous fine radiating striæ which ornament

the recent shell are scarcely more than skin deep, or penetrate beneath the epidermis, as may be seen at the umbo of the recent shell, which is generally eroded, but by a close inspection, these granulated striæ may be detected even in the fossil state.

In the Campinian beds of Belgium this shell does not appear to have been rare, but to have presented considerable diversity of form, and M. Nyst himself seems to admit, at page 199, the probability of his own three species being modifications or variations of *Isocardia cor*.

According to Knorr, this is called in France *Cœur de Bœuf*, or bullock's-heart, while in Holland it has the name of *Zots-Kappen*, or foolscap.

Genus Cyprina,* *Lamarck.* 1812.

Venus (sp.) *Auct.*
Arctica. *Schum.*, 1817.

Gen. Char. Shell equivalved, inequilateral, more or less orbicular, or obliquely heartshaped; smooth, or covered with irregular lines of growth, and in the recent state invested with an epidermis; umbones sharp, with a slight inclination to curve; the ventral margin smooth. Hinge with strong and prominent cardinal teeth in each valve, and one posterior lateral tooth. Muscle marks large, anterior one deeply impressed. Mantle mark with a small or incipient sinus. Ligament external.

Animal suborbicular, with mantle freely open, and finely serrated at the edges; siphonal tubes very short, and the margins of the openings fringed; foot large and linguiform.

The shells of this genus closely resemble in outward appearance some of the species of Venus, from which they were separated by Lamarck, who thought them of scarcely sufficient importance for generic distinction; there is, however, a marked difference in the impression of the mantle, which in this is without a sinus, denoting the possession in the animal of very short siphons; a large lateral tooth on the posterior margin is another character by which the shell may be distinguished. It appears to be very closely related to *Isocardia*. The species as yet known are all inhabitants of salt water, and in the living state are frequenters of gravelly sand or mud; they are somewhat of a large size, and of considerable solidity, and, as a genus, may perhaps date its existence as far back as the period of the Greensand Formation, continuing, though sparingly, through the Tertiaries to the present day, without numbering many species either in the existing state or in the ancient seas.

* Etym. κυπρις, one of the names of Venus.

1. Cyprina Islandica. *Linn.* Tab. XVIII, fig. 2 *a—d.*

Pectunculus maximus. *List.* Hist. Conch., fig. 108, 1685.
— — *Dacosta.* Brit. Conch., p. 183, t. xiv, fig. 5, 1778.
Venus Islandica. *Linn.* Syst. Nat., ed. 12, p. 1131, No. 124, 1767.
— — *Müll.* Zool. Dan., vol. i, p. 29, pl. xxviii, figs. 1—5, 1776.
— Icelandica. *W. Wood.* Ind. Test., pl. vii, fig. 41, 1825.
— mercenaria. *Penn.* Brit. Zool., ed. iv, vol. iv, p. 94, pl. liii, fig. 47.
— bucardium. *Born.* Mus. Cæs. Vind., t. iv, fig. 11, 1780.
— equalis. *J. Sow.* Min. Conch., t. xxi, 1813.
Cyprina Islandica. Ency. Meth., pl. 301, fig. 1 *a*, *b*, 1789.
— — *Phil.* En. Moll. Sic., vol. ii, p. 31, 1844.
— — *Nyst.* Conch. Foss. de Belg., p. 146, pl. ix, fig. 1, and pl. ii, fig. 1, 1844.
— — *Agass.* Icon. des Coq. Tert., p. 49, t. xiii, figs. 6, 7, 1845.
— — *Dekay.* Nat. Hist. New York Zool., pl. xxvi, figs. 268-9, 1843.
— — *Lovén.* Ind. Moll. Scand., p. 38, 1846.
— Islandicoides. *Nyst.* Coq. Foss. Prov. d'Anv., p. 9, No. 33, 1835.
— — *Pusch.* Pol. Pal., p. 74, pl. viii, fig. 5 *a—c*, 1837.
— angulata. *Nyst.* Rech. Coq. Foss. d'Anv., p. 9, No. 34, 1835.
— maxima. *S. Wood.* Catalogue, 1840.
— vulgaris. *G. B. Sow.* Genera of Shells, No. 32, 1824.
— æqualis. *Phil.* En. Moll. Sic., vol. i, p. 39, t. iv, fig. 4, 1836.
— — *Goldf.* Pet. Germ., p. 236, pl. 148, fig. 5, *a*, *b*.
— — *Agass.* Icon. des Coq. Tert., p. 52, t. xiii, fig. 5, 1845.
Arctica vulgaris. *Schum.* Essai d'un Nouv. Syst. des Habit. des Vers. Test., p. 145, pl. xiii, fig. 3, 1817.

Spec. Char. Testâ magnâ, subcordatâ, transversâ, vel orbiculari, tumidiusculâ; striis aut lineis incrementi tenuibus et irregularibus; umbonibus acutis vix incurvatis; latere postico subangulato.

Shell large, of a subcordate form, sometimes elongate or transverse, at others nearly orbicular, somewhat tumid, covered with fine and irregular lines of growth; beaks sharp, not prominent, scarcely incurved, posterior side slightly angulated.

Diameter, 4½ inches.

Localities. Cor. Crag, Gedgrave, Ramsholt.
Red Crag, Sutton, Bawdsey, Alderton, Felixstow.
Mam. Crag, Bridlington, Southwold, Chillesford.
Uddevalla and Clyde Beds.
Recent, British, Norwegian, and North American Seas.

This is one of the most common and abundant shells of the Coralline Crag, and although perfect specimens are somewhat difficult to obtain in the disturbed portion of the Red Crag, fragments or imperfect specimens are there of no uncommon occurrence, neither is it very rare in the still more recent deposit of the Mammaliferous Crag. It is found living upon our own coasts in various depths of water from five to thirty fathoms, and mostly where the bottom is of sandy mud, but it is considered as

more essentially a species of an Arctic character. From the examination of a large suite of fossil specimens obtained of different ages, I am convinced no specific separation can be made between these fossils and the shells now found living in our own, and in the Arctic seas; the form is a character upon which no dependence can be placed, as in some specimens the diameter in a longitudinal direction is considerably greater than when measured from the umbo to the ventral margin, as may be seen by the specimens that have been figured; while in others it is nearly orbicular, with the height equal or rather exceeding that of its length; as a general rule it may perhaps be said that the umbo of the Cor. Crag shell is thicker and more prominent than it is in the living species, but even in this there is considerable variation amongst my fossils, and in the shells of the more modern deposits this is less distinguishable.

This shell is said to attain in the living state to the large dimensions of five and a half inches in length, but I have never seen a Crag specimen of such magnitude; mine range from $4\frac{1}{2}$ inches, down to very little more than $\frac{1}{8}$th of an inch.

2. Cyprina rustica, *J. Sowerby*. Tab. XVIII, fig. 1 *a—e*.

Venus rustica. *J. Sow.* Min. Conch., t. 196, 1818.
Cyprina tumida. *Nyst.* Rech. Coq. Foss. d'Anv., p. 9, pl. ii, fig. 32, 1835.
— — *Potiez* and *Mich.* Cat. de Moll. de Douai, t. ii, p. 221.
— — *Nyst.* Coq. Foss. de Belg., p. 148, pl. x, fig. 1 *a*, *a*, *b*, *b*, and pl. viii, figs. 2, 3, and 4, 1844.
— rustica. *S. Wood.* Catalogue, 1840.
— Lajonkairii. *Goldf.* Pet. Germ., vol. ii, p. 237, t. 148, fig. 9 *a—c*, 1841.
— Defrancii. *Van Beneden.* Bull. Zool. de Guerin, 1835, p. 149, fide *Nyst.*

Spec. Char. Testâ tumidâ, globoso-cordatâ, valdè inæquilaterali; latere postico subquadrato; subtilissimè punctato-striatâ; umbonibus approximatis, subincurvis; lunulâ cordatâ, profundâ.

Shell tumid, globosely heartshaped, very inequilateral; posterior side subquadrate; covered externally with fine, radiating, and punctated striæ; umbones approximate, slightly incurved; lunule heartshaped and deep.

Length, $2\frac{3}{4}$ inches; *height*, $2\frac{1}{4}$ inches; *depth*, $2\frac{1}{4}$ inches.

Localities. Cor. Crag, Sudbourn, Gedgrave, Ramsholt.
Red Crag, Sutton, Newbourn.

This species is less abundant than the preceding one, although in the Coralline Crag at Gedgrave it is not of rare occurrence; from the Red Crag I have only been able to obtain a couple of specimens. The Belgian shell, which I believe to be the same species, is stated by M. Nyst to be very abundant in several localities.

This being undoubtedly the *Venus rustica* of Sowerby, I have retained his name as having a priority of date, and this author appears to have been the first to notice the species. The right valve has two cardinal teeth, the anterior one is of a triangular form, the posterior one is elongated and sharp, they fit into depressions of the same form between

three principal teeth in the left valve, with one distant, angular, and somewhat prominent lateral tooth in each; fulcrum for the ligament long and prominent, and in the old specimens of this species may be seen the oblong cavity before the ligament, while in the younger shell the fulcrum extends nearly to the umbo. The surface is covered with rather prominent and distinct lines of growth, and there are fine, radiating, and punctated striæ, but they are not always visible even with a lens, and were probably, like those upon *Isocardia cor*, most distinct in the epidermis. It is very variable in its outward form, some specimens being transverse and very inequilateral, while others are very orbicular, with a height rather exceeding the length; outwardly it so much resembles *Isocardia cor* as evidently to denote a close relationship.

Circe.* *Schum.*, 1817.

Venus (sp.) *Mont.*
Cyprina (sp.) *Turt.*
Cytherea (sp.) *Phil.*

Gen. Char. Shell equivalve, subtrigonal, orbicular or ovate, thick, strong, and closed; umbones sharp, not much elevated; lunule distinct, margins smooth. Hinge with three primary teeth in each valve, and one anterior lateral tooth. Ligament external; palleal impression with a very small sinus.

Animal suborbicular, with its mantle open, and the margins denticulated; two short siphonal tubes, with fringed orifices; foot large and tongue-shaped.

The authors of the 'History of British Mollusca' have adopted Schumacher's genus for the living homologue of our Crag species, although with some doubt respecting the propriety of the reference. The main features of distinction are the short or sessile appearance of the syphons, which correspond in that respect with those of *Cyprina* and *Astarte*, and they have placed it between those genera; the dentition of our only species resembles that of *Cytherea*, and if it does not strictly belong to the latter genus, deserves a situation but little removed from it.

1. Circe minima. *Montague.* Tab. XIX, fig. 2 *a—d.*

Venus minima. *Mont.* Test. Brit., p. 121, t. iii, fig. 3, 1803.
— triangularis. *Mont.* Test. Brit., p. 577, t. xvii, fig. 3, 1803.
— Cybilli. *Scacchi.* 1832, fide *Philippi.*
— pumila? *Desh.* 2d edit. Lam., tom. vi, p. 370, 1835, No. 86.
Cyprina minima. *Turt.* Brit. Biv., p. 137, 1822.
— — *Thorpe.* Brit. Mar. Conch., p. 82, fig. 102, 1844.

* Etym., proper name.

CYPRINA TRIANGULARIS. *Turt.* Brit. Biv., p. 136, pl. ii, figs. 19, 20, 1822.
CYTHEREA MINIMA. *Brown.* Brit. Conch. Illust., pl. xix, fig. 3, 1827.
— MINUTA. *Id.* „ „ pl. xix, fig. 4, 1827.
— TRIANGULARIS. *Macgil.* Moll. Aberd., p. 268, 1843.
— TRIGONA. *Nyst.* Coq. Foss. de Belg., p. 172, pl. xii, fig. 4, 1844.
— APICALIS. *Phil.* En. Moll. Sic., vol. i, p. 40, pl. iv, fig. 5, 1836.
— — *Forbes.* Ægean Invert. Rep. Brit. Assoc., p. 182, 1843.
— CYRILLI. *Phil.* En. Moll. Sic., vol. ii, p. 32, 1844.
— PUSILLA. *Bonelli* fide *Sismonda.*
— LENTICULA. *S. Wood.* Catalogue, 1840.
EXOLETA ORBICULATA? JUV. *Brown.* Brit. Conch. Illust., pl. xx, figs. 19, 20, 1827.
CIRCE TRIANGULARIS. *King.* Ann. Nat. Hist., vol. xv, p. 112.
— MINIMA. *Forb.* and *Hanl.* Hist. Brit. Moll., vol. i, p. 446, pl. xxvi, figs. 4, 5, 6, 8, and Animal, Pl. M, fig. 3, 1848.
CRASSINA MINIMA. *Gray.* Ann. of Philos., 1825.

Spec. Char. Testâ parvâ, ovato-rotundatâ vel subtrigonâ, subæquilaterali, compressâ, transversim striatâ, striis lævibus, convexis; lunulâ distinctâ; margine integerrimo.

Shell small, roundedly ovate, or of a subtrigonal form, nearly equilateral, compressed, transversely striated, striæ rounded and smooth; lunule distinct; margin smooth.

Diameter, $\frac{3}{8}$ths of an inch.

Localities. Cor. Crag, Sutton.
Red Crag, Sutton.
Recent, Ægean, Mediterranean, Britain, Zetland.

This species, in the Coralline Crag, is very abundant; my cabinet contains only two individuals from the Red Crag. In outward form it presents considerable variation, some specimens having a longitudinal diameter much greater than its height, while in others the height exceeds the length; the prominence in the umbo of some individuals gives rather an angularity to the upper part of the shell, but there is no distinct triangular variety.

CORALLIOPHAGA.* *De Blainv.*, 1824.

CYPRICARDIA (sp.) *Lamarck.*
VENERUPIS (sp.) *Basterot.*

Gen. Char. Shell transversely ovate or oblong, equivalved, inequilateral, closed; rugged or smooth externally; hinge furnished with two teeth in each valve, or two diverging in one valve, with one triangular and interlocking in the other. Two ovate muscular impressions; mantle mark with small indented sinus. Ligament external.

* Etym. κοράλλιον, coral, and φαγω, to eat.

Animal.

This appears to be distinguished by its dental formula having no lateral teeth like those in *Cypricardia*. What has hitherto constituted the genus *Venerupis*, is a greater number of cardinal hinge teeth, being three in a parallel direction, whereas in this there are only two diverging widely from the umbo. It appears to be closely related to the Venus family, but at present little is known respecting the few species that have as yet been noticed.

1. Coralliophaga cyprinoides. *S. Wood.* Tab. XV, fig. 7 *a—d.*

Coralliophaga cyprinoides. *S. Wood.* Catal. of Crag Shells, in Ann. and Mag. of Nat. Hist., 1840, p. 250.

Spec. Char. Testâ ovato-oblongâ, transversâ, valdè inæquilaterali, nitidâ, lævigatâ; anticè breviore, rotundatâ; posticè subtruncatâ; cardine bidentato divergente, sinu palliari minime profundo.

Shell ovately oblong, transverse, very inequilateral, naked, smooth, closed; anterior side the shorter, and rounded; posterior somewhat truncate; hinge with two diverging teeth, and a small palleal sinus.

Length, $\frac{6}{8}$ths of an inch; *height*, $\frac{1}{2}$ an inch.

Localities. Cor. Crag, Ramsholt, and Sutton.

This species does not appear to have been at all abundant. Var. *a* (fig. *b*, *c*), found within the walls of a Balanus, represents the right valve, which is very elongated, thin, and fragile; this is particularly inequilateral, rounded on the anterior side, somewhat quadrate posteriorly; the exterior is nearly smooth, or with merely irregular lines of growth, and it is rather more tumid on the posterior side, with a sort of obtuse diagonal ridge running from the umbo to the posterior part of the ventral margin; the hinge in this valve has a ledge or fulcrum for the ligament, within which is an elongated tooth nearly parallel, and behind the umbo, with a compressed one diverging under the anterior margin; in the left valve are also two teeth, one of which is of an obtusely triangular form, and seems to have been inserted between the two of the opposite valve, while the other fitted into the depression outside the anterior tooth of the right valve. Var. β (fig. *a*) is comparatively much shorter and thicker, and was found loose in the sand; the hinge area in this is broader and thicker; the marks of the adductor muscles are large and somewhat deeply impressed, and that by the mantle has but a very small indentation; the length of the larger specimen is as one and a half to its height, whereas the smaller variety is scarcely longer than it is high.

Venerupis striatula of Nyst, 'Coq. Foss. de Belg.,' p. 100, pl. iv, fig. 11 *a*, *b*, very much resembles our shell, but it has a large and deeply-indented sinus in the mantle-mark, and the shell to which he has referred his species has also the same distinguishing character.

Petricola coralliophaga, Desh., 'Coq. Foss. des Env. de Par.,' resembles one form of our variable shell, but from description the dental apparatus appears different. An individual, apparently of this genus, is in the cabinet of my friend Mr. F. Edwards, and found at Barton, but it is in so deplorable a condition that no fair comparison can be instituted.

Tapes.* *Megerle*, 1811.

Venus (sp.) *Linn.*
Callista, Callistoderma (sp.) *Poli*, 1791.
Tapes. *Schum.*, 1817.
Pullastra. *G. B. Sow.*, 1827.
Venerupis (sp.) *Flem.*, 1828.
Saxidomus? *Conrad*, 1837.

Gen. Char. Shell equivalve, transversely oblong, ovate, or subtriangular, inequilateral, closed, and generally somewhat thick and strong; posterior side the larger; externally smooth, striated, or decussated; inner margin free from crenulations. Hinge composed of three sub-parallel cardinal teeth, two of which are bifid. Palleal sinus large and deep. Ligament external.

Animal of an oblong form, having the mantle freely open in front; the margins plain, or sometimes fringed with fine filaments; siphons sometimes separated to their bases, at others united for half their length, with their orifices bordered by cirrhi; foot lanceolate and thick, furnished with a byssal groove.

This is an extensive genus, and species that may be referred to it have been obtained from the seas of all climates, some of which are extremely elegant, and in the recent state are beautifully ornamented. Many fossils from the older rocks, strongly resembling in form the recent genus, and possessing a mantle mark indicative of the possession of siphonal tubes, have been considered as entitled to a generic association; the distinctive characters, a byssal groove in the foot of the animal, of course is in the fossil perfectly useless, but the shell also possesses a good distinction in the peculiar arrangement of the hinge denticles; this, however, is another character seldom of much service in the older fossils, and it is only when we come into the Tertiaries that we are quite sure of its existence, and in the oldest of these it is doubtfully present.

1. Tapes virginea, . Tab. XX, fig. 1 *a—e*.

Venus virginea. *Mat.* and *Rack.* Linn. Trans., vol. viii, p. 89 t. ii, fig. 8, 1807.
— — *Turt.* Brit. Biv., p. 156, pl. 8, fig. 8, 1822.
— læta. *Poli.* Test. Utrusq. Sic., t. xxi, fig. 1.
— rhomboides. *Penn.* Brit. Zool., vol. iv, p.9 7, pl. lv, (fig. right hand.)
— sarniensis. *Turt.* Brit. Biv., p. 153, pl. x, fig. 6, 1822.

* Etym. ταπης, tapestry, probably so called from the ornamental exterior of most of the species.

VENUS VIRAGO. *Lovén.* Ind. Moll. Scand., p. 40, 1846.
CAPSA VIRGO. *"Leach."* Ann. Mag. Nat. Hist., vol. xx, p. 272.
CUNEUS FASCIATUS. *Dacosta.* Brit. Conch., p. 204, 1778.
VENERUPIS VIRGINEA. *Fleming.* Brit. Animals, p. 452, 1828.
— SARNIENSIS. *Id.* ,, p. 452.
PULLASTRA VIRGINEA. *S. Wood.* Catalogue, 1840.
— — *Forbes.* Rep. Ægean. Invert., p. 180, 1843.
TAPES VIRGINEA. *Forbes* and *Hanl.* Hist. Brit. Moll., vol. i, p. 388, pl. xxv, figs. 4, 6, 1848.

Spec. Char. Testâ ovatâ, compressiusculâ, inæquilaterali, posticè magiore et longiore, subangulatâ; concentricè inæqualiter striatâ, striis versùs posticum majoribus; lunulâ lanceolatâ.

Shell ovate, somewhat compressed, inequilateral, posterior side the larger and longer, subangulated, ornamented with concentric striæ or ridges, and these are larger or broader on the posterior side; lunule elongated.

Length, $1\frac{1}{2}$ inch; *height*, 1 inch.

Localities. Cor. Crag, Sutton.
Red Crag, Sutton, Walton-on-the-Naze.
Mam. Crag, Bramerton.
Uddevalla.
Recent, Norway, Britain, Mediterranean.

From the Coralline Crag my specimens are few and fragmentary; in the Red Crag it was not abundant; specimens, however, are in my cabinet sufficiently numerous and perfect to justify its being considered a fair identification, and I feel no hesitation in placing the Crag shell under the name of *virginea;* it appeared also to have continued through the more recent period of the Mam. Crag, as a specimen of this species was obligingly sent to me for description by Mr. Wigham, who found it in the neighbourhood of Norwich, and it is also enumerated among the shells from the Clyde beds. In the living state it is one of our most abundant as well as one of our handsomest species; and although our largest Crag specimen does not measure more than an inch and a half in length, the recent shell attains a magnitude of two and a half inches, a size exceeding those found in the Mediterranean.

2. TAPES AUREA, *Gmelin.* Tab. XX, fig. 2 *a—b.*

VENUS AUREA. *Gmel.* Syst. Nat., p. 3288, 1788.
— — *Mat.* and *Rack.* Linn. Trans., vol. viii, p. 90, pl. ii, fig. 9, 1807.
— — *Turt.* Brit. Biv., p. 155, pl. ix, figs. 7, 8, 1822.
— — *Phil.* En. Moll. Sic., vol. i, p. 47, vol. ii, p. 35.
— — *Lovén.* Ind. Moll. Scand., p. 40, 1846.
— — *Middendorff.* Malac. Ross., p. 569, 1849.
— ÆNEA. *Turt.* Brit. Biv., p. 152, pl. x, fig. 7, 1822.
— NITENS. *Id.* ,, p. 152, pl. x, fig. 8, 1822.
— NEBULOSA. *Solander.* Pult. Dorset., p. 34.

VENUS LITERATA. *Linn.* Faun Suec. non Syst. Nat.
CAPSA CROCEA. "*Leach.*" Mag. Nat. Hist., vol. xx, p. 272.
PULLASTRA AUREA. *Alder.* Catal. Moll. North. and Durh., p. 86.
TAPES AUREA. *Forb.* and *Hanl.* Hist. Brit. Moll., vol. i, p. 392, pl. xxv, fig. 5, 1848.

Spec. Char. Testâ ovatâ, sub-cordatâ, tumidiusculâ, sub-inæquilaterali, posticè angulatâ; margine ventrali arcuato; concentricè sulcatâ; striis radiantibus obsoletis; lunulâ cordato-ovatâ.

Shell ovate or heart-shaped, slightly tumid, inequilateral, posterior side angulated; ventral margin convex, concentrically sulcated, with obsolete radiating striæ; an elongated but not well-defined lunule.

Length, $1\frac{1}{8}$th of an inch; *height*, $\frac{7}{8}$ths ditto.

Localities. Mam. Crag, Bramerton.
Uddevalla.
Recent, Norway, Britain, Mediterranean.

The Mammaliferous Crag is its earliest appearance; one specimen only is all that I have seen, and that was found by Mr. Wigham, near Norwich, who has obligingly permitted me to have it figured. In the recent state this is a common species in the British seas upon the Eastern Coast, where it is subject to considerable variation, both in regard to form as well as in the external ornament, some specimens being, in fact, smooth, while others are deeply sulcated, or covered with regular ridges over the entire surface. The striæ upon the exterior of our solitary fossil specimen are fine and numerous; the anterior and posterior sides are somewhat compressed, while there is a tumidity about the middle of the shell differing therein from the preceding species, from which it also differs in being less elongated and rather less inequilateral.

3. TAPES PEROVALIS, *S. Wood.* Tab. XIX, fig. 7 *a—d.*

PULLASTRA PEROVALIS. *S. Wood.* Catalogue, 1840.

Spec. Char. Testâ elongato-ovatâ, inæquilaterali, tumidâ, nitidâ, politâ, tenui; anticè rotundato-angulatâ; margine dorsali postico convexiusculo.

Shell elongately ovate, inequilateral, tumid, smooth, glossy, and thin; anterior side roundedly pointed; dorsal margin slightly convex.

Length, 2 inches; *height*, $1\frac{1}{4}$ inch.

Locality. Cor. Crag, Ramsholt.

I have obtained at the above locality about a dozen specimens of this species, which from loss of animal matter had become excessively fragile.

In many of its characters it strongly resembles *Venus geographica*, but the smooth surface or total absence of the transverse ridges, as well as the radiating or decussating striæ which ornament that species, will readily distinguish it. A shell figured and described by Phillippi from the Neapolitan seas, *V. nitens*, En. Moll. Sic., vol. ii. p. 35, t. xiv, fig. 14, seems to approach even nearer, and may probably be identified

when the specimens can be compared; there are, however, some differences in the descriptions: it is therefore thought best to retain its present name. As this latter species appears its nearest relative, it may be only necessary to point out what are the distinctions, relying upon the description by that author, who, in comparing his shell with the *geographica*, seems to think a specific character exists in being less equilateral, and in the straight dorsal line of *nitens*, with a more convex ventral margin. Our shell, on the contrary, appears to have its dorsal margin more rounded than that of *geographica*, and much resembles in outline the *virginea*, but the smooth and glossy exterior differs from all that I have seen, with the exception of *nitens*; the dental characters appear the same, the central one bifid in the left valve, with two sub-bifid in the right; but the palleal scar, according to the figure, goes deeper into his shell than it does into our Crag fossil.

4. TAPES TEXTURATA? *Lamarck.* Tab. XX, fig. 3 *a—c.*

VENUS TEXTURATA. *Lam.* Hist. des An. sans Vert., 2d ed., p. 355, No. 43.
TAPES TEXTURATA. *G. Sowerby.* Thesaur. Conch. Tapes, No. 39.

Spec. Char. Testâ tenui, cordato-ovatâ, compressiusculâ, inæquilaterali; transversim striatâ, striis numerosis, confertis.

Shell thin, ovately heartshaped, somewhat compressed, inequilateral; transversely striated, striæ numerous, close set.

Length, $1\frac{1}{4}$ inch.

Locality. Red Crag, Walton-on-the Naze.

The specimen figured is the right valve with three teeth diverging from immediately beneath the umbo. The lines which cover the exterior are generally parallel to the margin of the shell, but they occasionally anastomose, or run into each other like those upon the recent species, *T. texturata*. There is, however, a slight difference in form from that shell, and the lunule is not so distinctly marked; but having only one specimen, and that imperfect, I am unwilling to do more than assign it provisionally to what appears at least its nearest relative; should, however, future examination of better specimens justify a specific distinction, I would claim for the Crag fossil the name of *habilis*.

VENERUPIS.* *Lamarck*, 1818.

VENUS (sp.) *Linn.*
DONAX (sp.) *Id.*
CUNEUS (sp.) *Dacosta.*
IRUS. *Oken*, 1815.
PETRICOLA (sp.) *Turt.*, 1822.
PETRIFORA. *Latr.*, 1827.
VENERIRUPIS. *Blainv.*, 1825, *G. Sow.*, 1839.
VENERUPES. *Swains.*, 1840.

* Etym., Venus, and rupis, a rock.

Gen. Char. Shell ovate or oblong, equivalved, inequilateral, somewhat compressed. Hinge composed of three cardinal teeth in one valve, and two or three in the other. Muscular impressions ovate, with a deep palleal sinus. Ligament external.

Animal oblong; the mantle closed all round with the exception of a small opening in front for the passage of the compressed and lanceolate foot; siphons unequal, disunited at about half their length; extremities ornamented with a double row of fringes.

The arrangement of dental characters in what constitutes this genus, as well as the general form of the shell, approach so closely to those of *Tapes*, that it seems more entitled to a position amongst the Venus family than to any other, and so far as the form of the foot of the animal or its siphons may determine its connections, it does not any further justify a removal; its habits certainly resemble those of *Saxicava*, but the selection as a habitat in holes, formed in rocks, is not peculiar to one family, as Bivalves of very different forms have been found located in such situations: and habits alone are not sufficient for the uniting into one family those Bivalves which possess them; perhaps, after all, this genus as it now stands will be found to possess no sufficient claims for a separate position, and may probably be hereafter united with *Tapes*.

As a genus it contains but very few species, and little is at present known respecting its exotic allies in the recent state, and nothing in the fossil of an older date than the Upper or Middle Tertiaries.

1. Venerupis irus. *Linnæus.* Tab. XIX, fig. 6 *a*, *b*.

Donax Irus. *Linn.* Syst. Nat., ed. 12, p. 1128, No. 111, 1767.
— — *Poli.* Test. Sicil., vol. i, t. x, figs. 1, 2, and vol. ii, p. 83, t. xix, figs. 25, 26, 1795.
Cuneus foliatus. *Dacosta.* Brit. Conch., p. 204, pl. xv, fig. 6, 1778.
Tellina Cornubiensis. *Penn.* Brit. Zool., ed. 4, vol. iv, p. 75, No. 35.
Venus Irus. *Brown.* Illust. Brit. Conch., pl. xx, fig. 9, 1827.
— rupestris? *Broc.* Conch. Foss. Subap., p. 559, t. xiv, fig. 1, 1814.
Venerupis Irus. *Lam.* An. sans Vert., t. v, p. 507, 1818.
— — *Payr.* Catal. Moll. Cors., p. 35, 1826.
— — *Phil.* En. Moll. Sic., vol. i, p. 21, vol. ii, p. 20.
— — *Forb.* and *Hanl.* Hist. Brit. Moll., vol. i, p. 156, pl. vii, figs. 1—3, and pl. G, fig. 2.
— — *Midden.* Malac. Rossic., p. 567.
Petricola Irus. *Turt.* Brit. Biv., p. 26, t. ii, fig. 14, 1822.
— rupestris? *Dubois.* Coq. Foss. Wolh. Pod., pl. vii, figs. 3, 4, 1831.
Pullastra Irus. *Brown.* Illust. Brit. Conch., 2d ed., pl. 37, fig. 9.
Capsa Irus. "*Leach*, 1818." Ann. and Mag. Nat. Hist., vol. xx, p. 272.
? Encyc. Method., pl. 262, fig. 4.

Spec. Char. Testâ ovato-oblongâ, vel subtrapezoidea, crassâ; posticè longiore et latiore, subangulatâ; lamellatâ, lamellis transversis, interstitiis radianter striatis; dentibus tribus in utraque valvâ; sinu palliari magno, subangulato.

Shell ovately oblong, or rather subtrapezoidal, thick, and strong; posterior side the longer and broader, somewhat angulated; ornamented with transverse lamellæ, radiatingly striated between the interstices; three teeth in each valve; palleal sinus large and subangulated.

Length, $\frac{5}{8}$ths of an inch; *height*, $\frac{3}{8}$ths ditto.

Locality. Red Crag, Walton-on-the-Naze.

Recent, Mediterranean, Britain.

Only two specimens of this species are in my cabinet, and they are all that I have seen; these are somewhat rubbed, with the lamellæ much worn down, but quite perfect enough to justify their being considered identical; my specimens are rather shorter than the generality of recent shells, although I believe in those there is considerable variation, and I have assigned it to the living species without any hesitation. In the recent state it is found imbedded in sponges and seaweed, as well as in rocks, and ranges from low-water mark to ten or a dozen fathoms.

Cytherea.* *Lamarck*, 1805.

Actinobulus. *Klein*, 1753.
Chama. *Browne*, 1756.
Venus (sp.) *Linn.*
Callista Callistoderma (sp.) *Poli*, 1795.
Hysteroconcha. *Lang.*, 1722.
Meretrix. *Lam.*, 1799.
Chione. *Gray*, 1838.
Dione. *Id.* 1848.
Gresslya (sp.) *Agass.*, 1845.

Gen. Char. Shell equivalve, inequilateral, closed, usually more or less transversely oblong or ovate, sometimes obtusely triangular, generally thick and strong, with slightly prominent umbones. Surface sometimes transversely sulcated, usually smooth. Hinge furnished with three teeth in one valve, and four in the other; anterior one diverging under the lunule. Muscular impressions large and ovate, that by the mantle with a sinus generally large and wide. Ligament external.

Animal of the form of the shell, with the mantle freely open, having the margins without fringes; siphons long, united nearly to their extremities; orifices surrounded with tentacles. Foot large and tongue-shaped, not furnished with a byssal groove.

This genus may be considered as being distinguished more especially by its peculiarity of hinge. The anterior tooth, which gives a prominent character to the genus, is placed at right angles to the more cardinal teeth, and is situated at a little distance immediately under the lunule, giving great firmness and security to the close union of the valves; the composition of the shell is also somewhat different from that

* Etym., one of the names of Venus.

of *Venus*, which has the outer portion of a fibrous character, while in this it is more compact, and in the recent shell is often enamelled.

This genus is found extensively in the warmer regions of the globe; as a fossil it has been obtained very low in the secondary Formations, and was largely developed during the early Tertiary Periods.

1. CYTHEREA CHIONE, *Linnæus*. Tab. XX, fig. 4 *a*, *b*.

CHAMA. *Regenfuss*. Choix Coquil., p. 56, t. viii, fig. 17.
CURVIROSTRUM. *Leigh*. Nat. Hist. Chesh., p. 179, pl. iii, fig. 5, 1700.
VENUS CHIONE. *Linn*. Syst. Nat., ed. 12, p. 1131, No. 125, 1767.
— — *Poli*. Test. Sicil., vol. ii, p. 85, pl. xx, figs. 1, 2, 1795.
— — *Broc*. Conch. Foss. Subap., p. 547, 1814.
— — *Sismonda*. Syn. Meth. Invert. Foss. Ped., p. 19, 1847.
— CHIONOIDES? *Nyst*. Coq. Foss. de Belg., p. 175, pl. xii, fig. 5 *a*, *b*, 1844.
PECTUNCULUS GLABER. *Dacosta*. Brit. Conch., p. 184, pl. xiv, fig. 7, 1778.
DIONE GLABER. *Gray*. List Brit. Moll., p. 6, 1851.
CYTHEREA CHIONE. *Turt*. Brit. Biv., p. 160, pl. viii, fig. 11, 1822.
— — *Payr*. Catal. Moll. Corse., p. 47, 1826.
— — *Bronn*. Leth. Geogn., ii, p. 954, t. xxxviii, fig. 3*a*—*c*, 1838.
— — *Phil*. En. Moll. Sic., vol. i, p. 40, vol. ii, p. 31.
— — *Owen*. Comp. Anat. Invert. An. p. 282, fig. 118, 1843.
— — *Forbes*. Ægean Invert. Rep. Brit. Assoc., p. 180, 1843.
— — *Agass*. Icon. des. Coq. Tert., p. 45, t. x, figs. 10—13, 1845.
— NITENS. *Andr*. Bull. de Sc. de Mosc. p. 104, pl. vi, fig. 9, 1830, fide *Bronn*.
— LÆVIS. *Agass*. Loc. cit. supra, t. x.
CYTHERÉE FAUVE. *Chenu*. Traité Element., pl. iii, fig. 10.
Encyc. Method., pl. 266, fig. 1 *a*. *b*,

Spec. Char. Testâ transversâ, ovato-cordatâ, inæquilaterali, glabrâ, politâ, transversim obsoletè sulcatâ; lunulâ elongatâ; anticè et posticè rotundatâ.

Shell transverse, ovate, heartshaped, inequilateral, very smooth, and glossy; with obsolete transverse ridges; lunule elongate, and cordiform: anterior and posterior sides rounded.

Length, $2\frac{1}{2}$ inches; *height*, $1\frac{3}{4}$ ditto.

Locality. Cor. Crag, Ramsholt

Recent, Britain, Mediterranean.

This elegant and beautiful shell I have seen only from the oldest of the Crag Deposits, and in that from the lowest part, where it is not rare, but of extreme fragility, and specimens are very difficult to be obtained.

The Crag shell agrees precisely with the British form of this species, in the exterior being smooth and glossy, and marked in a concentric direction, with occasionally shallow or indistinct furrows, or depressions, and with the aid of a lens may be seen numerous, fine, radiating striæ, most visible upon the posterior side; these, however, are quite superficial, and are not seen when the surface is removed, nor is it imparted in any way to the margin of the shell which is quite smooth.

Poli has given a beautiful drawing of the animal of this species, and its anatomy is described by Professor Owen in his Lectures upon Invertebrate Animals, where he considers it as one of the most highly organised of the Bivalvia. In the recent state this does not appear to have been a very deep water species, and seems more inclined to the southern or Mediterranean regions, where it is very abundant, and as a fossil I know it only from the Sicilian beds, unless *Venus chionoides*, Nyst, be one of its varieties. *C. Chione*, Dubois, Wolhyn. Podol., pl. v, figs. 13, 14, appears to have ridges too regular and too numerous, and according to the figure, is rather too broad on the posterior side, with the sinus in the mantle mark more rounded, and appears to be intermediate between our shell and *Erycinoides*.

Cytherea nitidula, Lam., a recent species from the Mediterranean, is considered by Philippi as the young of this shell, but the fossil from the older Tertiaries described under the same name, is quite distinct.

2. Cytherea rudis, *Poli*. Tab. XX, fig. 5 *a—d*.

Venus rudis. *Poli*, (not Dujard.) Test. Sicil., vol. ii, p. 94, t. xx, figs. 15, 16, 1795.
— — *Middendorff*. Malacozool. Rossica, p. 571, 1849.
— pectunculus. *Broc*. Conch. Foss. Subap., p. 560, pl. xiii, fig. 12, 1814.
— cycladiformis. *Nyst*. Coq. Foss. de Belg., p. 171, pl. xii, fig. 3, 1844.
— Venetiana. *Sismonda*. Syn. Meth. Invert. Pedm., p. 20, 1847.
— ochropicta. *Krynicki*. Bull. des Natur. de Mosc., No. 11, p. 64, fide *Middendorff*.
Cytherea Venetiana. *Lam*. Hist. des An. s. Vert., tom. v, p. 569, 1818.
— — *Phil*. En. Moll. Sic., vol. i, p. xl, t. iv, fig. 8, 1836.
— — *Dujard*. Mem. de la Soc. Geol. de Fr., t. ii, part ii, p. 260, 1837.
— — *Forbes*. Ægean Invert. Rep. Brit. Assoc., p. 182, 1843.
— filosa. *S. Wood*. Catalogue, 1840.
— cycladiformis. *Nyst*. Rech. Coq. Foss. d'Anv., p. 10, No. 38, pl. ii, fig. 38, 1835.
— rudis. *Phil*. En. Moll. Sic., vol. ii, p. 32, 1844.

Spec. Char. Testâ obliquè-cordatâ, tumidâ, inæquilaterali, tenui, transversim striatâ, striis tenuibus, rotundatis, confertis; lunulâ elongato-cordatâ, margine integro; umbonibus, prominulis.

Shell obliquely heartshaped, tumid, inequilateral, thin, transversely or concentrically striated; striæ fine, close, and rounded; lunule of an elongated heartshape; margin smooth; beaks slightly prominent.

Length, $\frac{7}{8}$ths of an inch; *height*, $\frac{3}{4}$ths of an inch.

Localities. Cor. Crag, Sutton, Ramsholt, Sudbourn.
Red Crag, Sutton, and Walton-on-the-Naze.
Recent, Mediterranean, and Black Sea.

This delicate and elegant shell is very abundant in the Red Crag at Walton-on-the-Naze, and not at all rare in the Lower Formation, or Cor. Crag at Sutton.

It is subject to considerable variation in outline, and in proportional dimensions,

but in general the form is transverse, with a diameter of seven to five; while in others there is no difference, the height being equal to the length. The hinge is furnished with three teeth in the right valve, and four in the left, the posterior one small, parallel to, and a little within the fulcrum for the ligament: in the right valve the posterior tooth is bifid or cleft; the surface is ornamented with numerous close set striæ, broader than the spaces between them, and sometimes rather irregular, bifurcating or inosculating, more especially on the posterior part; the impression of the mantle is at some distance within the margin, and the sinus large, rounded, and reaching about one third across the shell.

A species from the older Tertiaries at Barton, figured and described by J. Sowerby in 'Min. Conch.,' t. 422, fig. 2, (*V. rotundata*, Brander, figs. 91, 93,) very much resembles our Crag fossil, but is, I believe, distinct.

Venus. *Linnæus.*

Callista and Callistoderma (sp.) *Poli*, 1795
Antigone. *Schum.*, 1817.
Venulites. *Schlott.*, 1820.
Clausina. *Brown*, 1827.
Ortygia. "*Leach, MS.*," id.
Timoclea. *Id.* id.
Chione. *Megerle*. 1811; *Gray*, 1851.
Dosina. *Gray*, 1838; *Wood*, 1840.
Egesta? *Conrad*, 1845.

Gen. Char. Shell equivalve, more or less inequilateral, closed; orbicular or transversely ovate, generally ornamented upon the exterior, imbricated, radiated, or decussated. Margin crenulated. Hinge composed of three diverging cardinal teeth in each valve. Ligament external. Muscular impressions roundedly ovate. Mantle mark sinuated.

Animal ovate or suborbicular, with the edges of the mantle disconnected; margins fringed. Siphons united at the base, separated and diverging at their extremities; orifices fimbriated; foot linguiform.

This genus, as the name would imply, is composed of beautiful, and in the living state, of many highly ornamented shells, and found in the seas of all regions. Notwithstanding its great curtailment since the time it was established by Linnæus, it now contains at least a hundred well determined species, restricting them to such as possess a dental armature of three diverging cardinal teeth, while the animal possesses two rather short siphons, giving a somewhat small and angular sinus to the impression of the mantle mark; the texture of the shell, at least the outer portion of it, appears to be of a fibrous character, and it is generally covered with fine and numerous striæ in a radiating direction, and is more or less ornamented with reflexed portions of the margin or imbrications, and some few are armed with long and formidable looking spines.

Fossils in the Carboniferous Deposits have been assigned to this genus, but perhaps their just claim will not go further than a resemblance, or what is called a family relationship, their true characters not having been well determined.

1. VENUS CASINA, *Linnæus.* Tab. XIX, fig. 1 *a—f.*

VENUS CASINA. *Linn.* Syst. Nat., 12 ed., p. 1130, No. 117, 1767.
— — *Dujard.* Mem. de la Soc. Geol. de Fr., t. ii, part 2, p. 261, 1837.
— — *Phil.* En. Moll. Sic., vol. ii, p. 33, 1844.
— — *Lovén.* Ind. Moll. Scand., p. 39, 1846.
— DISCINA. *Lam.* An. sans Vert., t. v, p. 586, 1818.
— REFLEXA. *Mont.* Test. Brit. Suppl., pp. 41, 168, 1808.
— RUSTERUCII. *Payr.* Cat. Moll. Cors., p. 52, pl. i, figs. 26—28, 1826.
— GIBBOSA. *J. Sow.* Min. Conch., t. 155, fig. 3, 1817.
— TURGIDA. *J. Sowerby.* Min. Conch., t. 256, 1820.
— — *Nyst.* Conch. Foss. de Belg., p. 178, pl. xiii, fig. 4 *a*, *b*, 1844.
— SENILIS? *Dubois.* Wolhyn. Podol., p. 60, pl. v, figs. 22, 23.
— SULCATA. *Nyst.* Loc. cit. sup., p. 177, pl. xii, fig. 6 *a*, *b*, 1844.
— MULTILAMELLOSA? *Nyst.* Id., p. 179, pl. xii, fig. 7 *a*, *b*.
— SIMILIS? *Id.* Id., p. 180, pl. xiii, fig. 5 *a*, *b*.
— GALLINA? *Bronn.* Leth. Geog., vol. ii, p. 948, t. xxxviii, fig. 6.
— CASINULA? *Desh.* Exped. Morèe, p. 101, t. xviii, figs. 18, 19.
— CINCTA. *Agass.* Icon. des Coq. Tert., p. 36, t. iv, figs. 7—10, 1845.
PECTUNCULUS MEMBRANACEUS. *Dacosta.* Brit. Conch., pl. xiii, fig. 4.
CYTHEREA SULCATA. *Nyst* et *West.* Nouv. Rech. des Foss. d'Anv., pl. i, fig. 9, 1839.
— LAMELLATA. *Id.* „ „ „ p. 9, pl. i, fig. 10.
CLAUSINA REFLEXA. *Brown.* Illust. Brit. Conch.. pl. xix, fig. 13, 1827.
— CASINA „ „ „ pl. xx, fig. 15.
DOSINA CASINA. *Gray,* Analyst, 1838.
— TURGIDA. *S. Wood.* Catalogue.

Spec. Char. Testâ cordato-rotundatâ, gibbosâ, interdum compressâ, crassâ; imbricatâ vel lamellatâ; lamellibus confertis, acutis; margine crenulato; lunulâ distinctâ, impressâ.

Shell roundedly heartshaped, gibbous, sometimes compressed, thick, and covered with concentric imbrications, close, sharp, and reflexed; margin crenulated; lunule distinct, impressed.

Diameter. 2 inches, nearly.

Localities. Cor. Crag, Ramsholt, Sutton, Gedgrave, Sudbourn.
Red Crag, Sutton, Bawdsey, Felixstow, Alderton.
Mam. Crag, ? Clyde beds.
Recent, Mediterranean, Britain, Bergen.

This shell as a Crag fossil is everywhere abundant, and exceedingly variable in outward form, being sometimes longer than it is high, while in other specimens the diameter is greater in the opposite direction; in some individuals there is considerable tumidity, while others are much compressed.

It is assigned to the living species from the belief that some of its varieties

are so intimately connected that no specific character can be pointed out, whereby it can possibly be distinguished or separated from it.

In the recent shell the umbo appears, in the few specimens I have been able to examine, to be a little more lateral than in the generality of the Crag fossils, although this lateral incurvature of the umbo is quite as distinct in the extreme of its variation as in the living shell. Although considered as extinct by all previous authorities, and to which I submitted when compiling my own Catalogue, the possession of many more varieties, and further examination, have given me reason to dissent from that opinion. The lamellæ of the fossil are not often preserved in Cabinet specimens; when visible they are sharp and erect, and about equidistant, rather less prominent upon the posterior margin, but that is a character upon which two species in the living state have been formed, and is not much to be depended on; between the lamellæ fine radiating striæ are visible, corresponding to the crenulated margin of the interior.

2. Venus fasciata, *Dacosta*. Tab. XIX, fig. 5 *a—c*.

Pectunculus fasciatus. *Dacosta*. Brit. Conch., p. 188, t. xiii, fig. 3, 1778.
Venus Paphia. *Pulteney*. Hutchins' Hist. Dorset., p. 33.
— — *Mont*. Test. Brit., p. 110, 1803.
— fasciata. *Don*. Brit. Shells, vol. v, pl. 170, 1803.
— — *Phill*. En. Moll. Sic., vol. ii, p. 34, 1844.
— — *Lovén*. Ind. Moll. Scand., p. 39, 1846.
— — *Forb*. and *Hanl*. Hist. Brit. Moll., vol. i, p. 415, pl. 23, fig. 3, pl. xxvi, fig. 7, and pl. L, fig. 7, 1848.
— Brogniarti. *Payr*. Cat. Moll. Cors., p. 51, pl. i, figs. 23—25, 1826.
— — *Phil*. En. Moll. Sic., vol. i, p. 43, 1836.
Chione fasciata. *Gray*. List Brit. Moll., 1851.
Clausina fasciata. *Brown*. Illust. Brit. Conch., pl. xx, fig. 10, 1827.
Dosina — *S Wood*. Catalogue, 1840.
Pectunculus fasciatis. *List*. Hist. Conch., lib. iii, sect. 4, fig. 114, 1688.
Encyc. Method., pl. 276, fig. 2.

Spec. Char. Testâ crassâ, compressiusculâ, ovato-trigonâ vel sub-cordatâ, inæquilaterali, latere postico longiore; lamellatâ, lamellis crassis, recurvis, distantibus; lunulâ elongato-cordatâ; umbonibus prominulis.

Shell thick, somewhat compressed, triangularly ovate, inequilateral, posterior side the longer, and very little pointed; covered with thick, distant, and slightly recurved lamellæ, or concentric ridges; lunule elongated, heart shape.

Length, $\frac{3}{4}$ths of an inch; *height*, $\frac{5}{8}$ths ditto.

Localities. Red Crag, Sutton, Walton-on-the-Naze.
Mam. Crag, Bramerton.
Recent, Mediterranean, Britain, Scandinavia.

I have only met with true and genuine specimens of this species as far back as the Red Crag, where it was not very abundant. The young state of *Venus imbricata*, in some of its forms, strongly resembles this shell, except where the lamellæ are well pre-

served: in this species the ridges are more numerous about the umbo or in the young shell, whereas in the other they are more prominent and distant, and in the mature state this species never attains to so great a size: the posterior side is sometimes slightly pointed, and the length is generally greater than the height, but occasionally the greater dimensions are the reverse. In the living state it is said to have a vertical range from four to sixty fathoms.

3. Venus imbricata, *J. Sowerby*. Tab. XIX, fig. 3 *a—f*.

Astarte imbricata. *J. Sow.* Min. Conch., t. 521, fig. 1, 1826.
— — *Nyst.* Coq. Foss, de Belg., p. 153, pl. ix, fig. 3 *a*, *b*, 1844.
Dosina imbricata. *S. Wood.* Catalogue, 1840.

Spec. Char. Testâ suborbiculari, subcordatâ, compressiusculâ aut tumidâ, crassâ, imbricatâ, imbricibus crassis 12—16, *reflexis, striatis; natibus recurvis; lunulâ ovato-cordatâ; marginibus crenulatis; sinu palliari parvo, angulato.*

Shell suborbicular, slightly heartshaped, somewhat compressed, occasionally tumid, thick and imbricated, with 12—16 broad, thick, reflexed ridges or imbrications; umbones recurved; lunule impressed, elongate; margins crenulated; palleal sinus small and angular.

Diameter, $1\frac{1}{4}$ inch.

Localities. Cor. Crag, Ramsholt, and Gedgrave.
Red Crag, Sutton, Walton-on-the-Naze.

This species is not particularly abundant either in the Coralline or in the Red Crag, and appears in both to be subject to considerable variation.

There are two very distinct forms in this species: what may be called var. *a*, (fig. *c*, *d*,) which, in its extreme form, is an elegant shell, curving considerably towards the anterior, and ornamented with about sixteen thick, obtuse, but reflected ridges, at nearly regular distances, the fine lamellated ornament of the young shell is worn down in those from the Red Crag, from which Formation only I have seen this variety. In this state it approaches very near to *V. casina*, differing only in the exterior ornament. Var. β, or *gibberosa*, (fig. *e*,*f*,) on the contrary, is very inelegant, being a thick, tumid, and clumsy looking shell, with a hunchedback and, in most instances, bipartite, the older portion having a very different appearance from that of the young shell, in which the surface is furnished with a few sharp, erect, and distant lamellæ, about eight or ten, and these, at the extreme edge or posterior margin, terminate abruptly, and are sharp and almost pointed, after which the shell is nearly smooth, the lamellæ being so close as to represent little more than lines of growth with an irregular surface. In this variety the shell is nearly orbicular, very tumid, and is rather higher than it is long, the other variety is more compressed, and the diameter is greater in a longitudinal direction; between these extremes there is every imaginable variation, and the specimen represented in 'Min. Conch.,' appears somewhat of an intermediate character, having the surface flattened by the abrasion of the lamellæ.

2. VENUS OVATA, *Pennant.* Tab. XIX, fig. 4 *a—d.*

VENUS OVATA. *Penn.* Brit. Zool., vol. iv, p. 206, t. 59, fig. 3, 1777.
— — *Forbes.* Ægean Invert. Rep. Brit. Assoc., p. 182, 1843.
— — *Lovén.* Ind. Moll. Scand., p. 40, 1846.
— — *Forb.* and *Hanl.* Hist. Brit. Moll., vol. i, p. 419, pl. xxxiv, fig. 2, and pl. xxvi, fig. 1, and pl. L, fig. 6, 1848.
— RADIATA. *Broc.* Conch. Foss. Subap., p. 543, t. xiv, fig. 3 *a, b,* 1814.
— — *Bast.* Mem. Soc. d'Hist. Nat. de Par., t. ii, pt. i, p. 89.
— — *Marcel de Serres.* Geog. des Terr. Tert., p. 150, 1829.
— — *Phil.* En. Moll. Sic., vol. i, p. 44, vol. ii, p. 34.
— SPADICEA. *Renieri.* Fide Brocchi.
— — *Nyst.* Coq. Foss. de Belg., p. 165, pl. ii, fig. 3, 1844.
— PECTINULA. *Desh.* 2d. edit. Lam., t. vi, p. 348, 1 35.
CARDIUM STRIATUM RADIATUM. *Walk.* and *Boys,* Test. Min. Ror., p. 23, fig. 82, 1787.
TIMOCLEA OVATA. *Brown.* Illust. Brit. Conch., pl. xix, fig. 11, 1827.
— PENNANTII. *Leach, MS.* Fide Brown.
CYTHEREA OVATA. *Fleming.* Brit. An., p. 445, 1828.
CHIONE OVATA. *Gray.* List of Brit. Moll., p. 11, 1851.

Spec. Char. Testâ ovato-trigonulâ, inæquilaterali, crassâ, anticè rotundatâ, posticè angulatâ; radiatim sulcatâ, sulcis granulatis; lunulâ distinctâ elongato-cordatâ; margine tenuissimè crenulato.

Shell triangularly ovate, inequilateral, thick; anterior side rounded, posterior very slightly elongated; covered with radiating, bifurcating, and granulated striæ; lunule elongated, heartshaped; margin very finely crenulated.

Length, $\frac{5}{8}$ths of an inch; *height,* $\frac{1}{2}$ an inch.

Localities. Cor. Crag, Sutton, Gedgrave.
Red Crag, Sutton.
Recent, Mediterranean, Britain, Scandinavia.

This shell is exceedingly scarce in the Red Crag, but in the older or subjacent deposit it is particularly abundant, more especially at Sutton, where the specimens are almost entirely of one variety, in which the rays are finer and flatter, bifurcating about the middle of the shell, giving, on the outer portion, as many as forty or fifty ridges; those which are found at Gedgrave have the rays larger, more elevated, and rounded, with a more roughened surface, and are seldom divided, having also a wider space between them: in the other variety they are but little imbricated, and have the intermediate spaces or sulci very narrow; the form is somewhat variable, but in general the older shell has comparatively a greater length than in the young state, and is always a little longer than it is high; upon the Gedgrave shell, or var. β, there is an obtuse ridge upon the posterior side, behind which the rays are closer and more numerous; this corresponds with the Italian fossil, *V. radiata,* Broc., while the Sutton specimens more resemble the common form of the recent British shell.

This species is said to be abundant in the British seas, with a vertical range from three to one hundred fathoms; it is found fossil at Stromstadt.

Artemis,* *Poli.* 1791.

Chama (Dosin.) *Adans.*, 1757.
Dosinia. *Scopoli*, 1777; *Gray*, 1851.
Circomphalus (sp.) *Klein*, 1753.
Artemis et Artemiderma. *Poli*, 1791.
Orbiculus. *Megerle*, 1811.
Asa. *Leach, MSS.*, 1819, fide *Defrance.*
Exoleta. *Brown*, 1827.
Arctoë. *Risso*, 1826.
Taras. *Id.*
Arthemis. *Desh., Phil., Blainv., Agass.*

Gen. Char. Shell suborbicular or lenticular, equivalved, more or less compressed, generally strong and closed, surface covered with concentric striæ; margins entire. Hinge composed of three cardinal teeth in one valve, and four in the other; no lateral teeth. Ligament external, with a strongly defined, and generally deep lunule. Impressions of the adductor muscles ovate, nearly equal, that by the mantle deeply sinuated.

Animal suborbicular, with the edges of the mantle mostly disconnected; margins entire, or partially serrated. Siphonal tubes long, united to their extremities. Foot large, semilunar, or crescent-shaped, exsertible at the middle or basal margin of the valves.

This is a well-marked genus, said to be characterised especially by its animal inhabitant, but if our reliance were solely upon the softer parts, to the entire exclusion of the shell, it might be difficult to know where it should be placed. There is, however, not much doubt respecting its relationship to the Venus group, but this affinity is better displayed in the hard or shelly covering of the animal, than by any general resemblance of either the foot, or the siphons of the mantle. The long siphonal tubes of this genus are indicated in the shell by the impression of the retractor muscles being placed far in the interior, so as to give what is called a very deep palleal scar or sinus, denoting, by its depth, a corresponding proportion in the length of the tubes, this however, is not an infallible criterion as to their length, nor does it appear to be a character of any great family dependence, for in *Lucinopsis* the interior of the shell is marked by the impression of the mantle with quite as deep a sinus, while the animal has the tubes short and slightly exsertile, with a slender and delicate foot, and has little or no resemblance, any further than in the form of the mantle mark, to animals of this genus, where the siphons are long and united, and the foot is broad and splayed.

In the recent state it has a wide geographical range; as a fossil I am not aware of its having been found in any older Formation than the Middle Tertiaries.

* Etym., a proper name.

1. ARTEMIS LENTIFORMIS, *J. Sowerby*. Tab. XX, fig. 7 *a—c*.

VENUS EXOLETA. *Parkinson*. Org. Rem., vol. iii, p. 189, 1811.
— LENTIFORMIS. *J. Sow*. Min. Conch., t. 203, 1818.
ARTEMIS EXOLETA. *Nyst*. Coq. Foss. Belg., p. 184, pl. xiv, fig. 1, 1844.
— LENTIFORMIS. *S. Wood*. Catalogue, 1840.
— — *Potiez* et *Mich*. Catal. des Moll. de Douai, tom. xi, p. 227, No. 13, 1844.

Spec. Char. Testâ orbiculari, lentiformi, compressiusculâ inæquilaterali, crassâ; striis concentricis, magnis, confertis; lunulâ cordatâ, impressâ; margine dorsali convexiusculo posticè subangulato.

Shell orbicular, lentiform, somewhat compressed, slightly inequilateral, thick; covered with numerous large, close set, concentric striæ; a deeply-seated heartshaped lunule; dorsal margin slightly convex; posterior side subangulated.

Diameter, 2 inches.

Localities. Cor. Crag? Gedgrave.
Red Crag, Sutton, Walton-on-the-Naze.

In the Coralline Crag it is very rare; indeed I have obtained only one specimen, which is represented at fig. 7 *c*, and this is partly imbedded in the matrix with its best characters obscured; but in the Red Crag it is one of the most abundant shells at Walton-on-the-Naze.

In the 'Mineral Concology' the Crag shell was considered to differ from *Venus exoleta* (with which it had been placed by Parkinson) sufficiently to justify a specific distinction, and as this is a genus in which the species do not appear to possess a great range in variation, I have retained for it Mr. Sowerby's name, although these differences are probably the effect of locality, or the result of external conditions.

Our shell is certainly flatter than *V. exoleta*, but not thinner; the striæ or ridges are as large and broad as those which ornament the recent species; there is a slight angularity in the outline on the posterior side, a little beyond the termination of the large ligament, and a slight slope upon the dorsal edge, differing therein from *V. exoleta*; this slope is not naked, but covered with numerous striæ or fine lines of growth. The sinus in the mantlemark is large, deep, and linguiform in a direction across the shell; I have never seen a specimen with this sinus so vertical as it is represented in 'Min. Conch.' above referred to.

2. ARTEMIS LINCTA, *Pulteney*. Tab. XX, fig. 6 *a—d*.

VENUS LINCTA. *Pult*. Hutchins, Dorset, p. 34, fide Forb. and Hanl.
— EXOLETA. *Penn*. Brit. Zool., vol. iv, p. 94, pl. lvi, fig. 49.
— — var. *β*. *Mat*. and *Rack*. Linn. Trans., vol. viii, p. 87, pl. iii, fig. 2, 1807.
— SINUATA. *Turt*. Ed. Linn., vol. iv, p. 233, 1806.
— LUPINA. *Poli*. Test. Sicil., t. xxi, fig. 8.
— LACTEA. *Mont*. Test. Brit. Sup., p. 46, 1808.

CYTHEREA LINCTA. *Lam.* An. sans Vert., t. v, p. 573, 1818.
— — ? *Basterot.* Bord. Foss., p. 90, pl. vi, fig. 10, 1825.
— — *Phil.* En. Moll. Sic., vol. i, p. 41, vol. ii, p. 32.
— — *Dujard.* Mém. Soc. Géol. de France, t. ii, part ii, p. 260, 1837.
— — *Bronn.* Leth. Géogn., p. 955, t. xxxviii, fig. 4 *a—c*, 1838.
— SINUATA. *Turt.* Brit. Biv., p. 163, 1822.
ASA LINEATA. *Leach, MSS.* Defrance, Coll. ex Basterot.
EXOLETA LINCTA. *Brown.* Illust. Brit. Conch., pl. xx, fig. 4, 1827.
ARTEMIS — *Forbes.* Ægean. Invert. Rep. Brit. Assoc., p. 180, 1843.
— — *Lovén.* Ind. Moll. Scand., p. 39, 1846.
— — *Forb.* and *Hanl.* Hist. Brit. Moll., vol. i, p. 431, pl. xxviii, figs. 5, 6, 1848.
— SINUATA. *S. Wood.* Catalogue, 1840.
— COMPTA. *Lovén.* Ind. Moll. Scand., p. 39, fide Alder.
ARTHEMIS LINCTA. *Agassiz.* Icon. des Coq. Tertiares (Extr. des Nonv. Mém. de la Soc. Helv. des Sc. Nat., tome vii, 1845,) p. 22, t. iii, figs. 11—14.
DOSINIA LINCTA. *Gray.* List. Brit. Moll., p. 4, 1851.
Lister. Hist. Conch., lib. iii, fig. 126.

Spec. Char. Testá suborbiculari, lentiformi, subinæquilaterali, concentricè striatá, striis numerosis, confertis lævibus; lunulá cordatá impressá.

Shell suborbicular, lentiform, subinequilateral, fragile, covered with numerous close set striæ; lunule heartshaped; impression of the mantle with a deep tongue-shaped sinus.

Diameter, $1\frac{1}{2}$ inch.

Localities. Cor. Crag, Sutton, Ramsholt.
Red Crag, Walton-on-the-Naze.
Recent, Mediterranean, British and Norwegian Seas.

Not very rare either in the Coralline or in the Red Crag, but the specimens are in general extremely fragile and very difficult to procure; they are much thinner than those of the preceding species, and appear to have less of animal matter remaining; although this is much less abundant than *A. lentiformis*, it appears to present a greater diversity of character in the outline, and I have thought it necessary that two forms should be represented: where individuals have become more elongated than what might be considered as the normal form of the species the shell is invariably more convex or tumid, so that an equal quantity of space is occupied by the animal.

It is said in the recent state in the British seas to have a range in depth varying from low water mark to the depth of sixty fathoms.

Mr. Smith, of Jordan Hill, enumerates *Cytherea exoleta* in his Catalogue of Shells from the Clyde Beds. Mem. Wern. Nat. Hist. Soc., v l. viii, p. 45, 1838.

TAB. XIII.

Fig.

1 *a—d.* Cardium Groenlandicum, *page* 160.

2 *a, b.* „ venustum, *p.* 160.

3 *a, b.* „ nodosulum, *p.* 154.

c. „ „ portion of surface magnified.

4 *a, b.* „ nodosum, *p.* 153.

c. „ „ portion of surface magnified.

5 *a, b.* „ strigilliferum, *p.* 154.

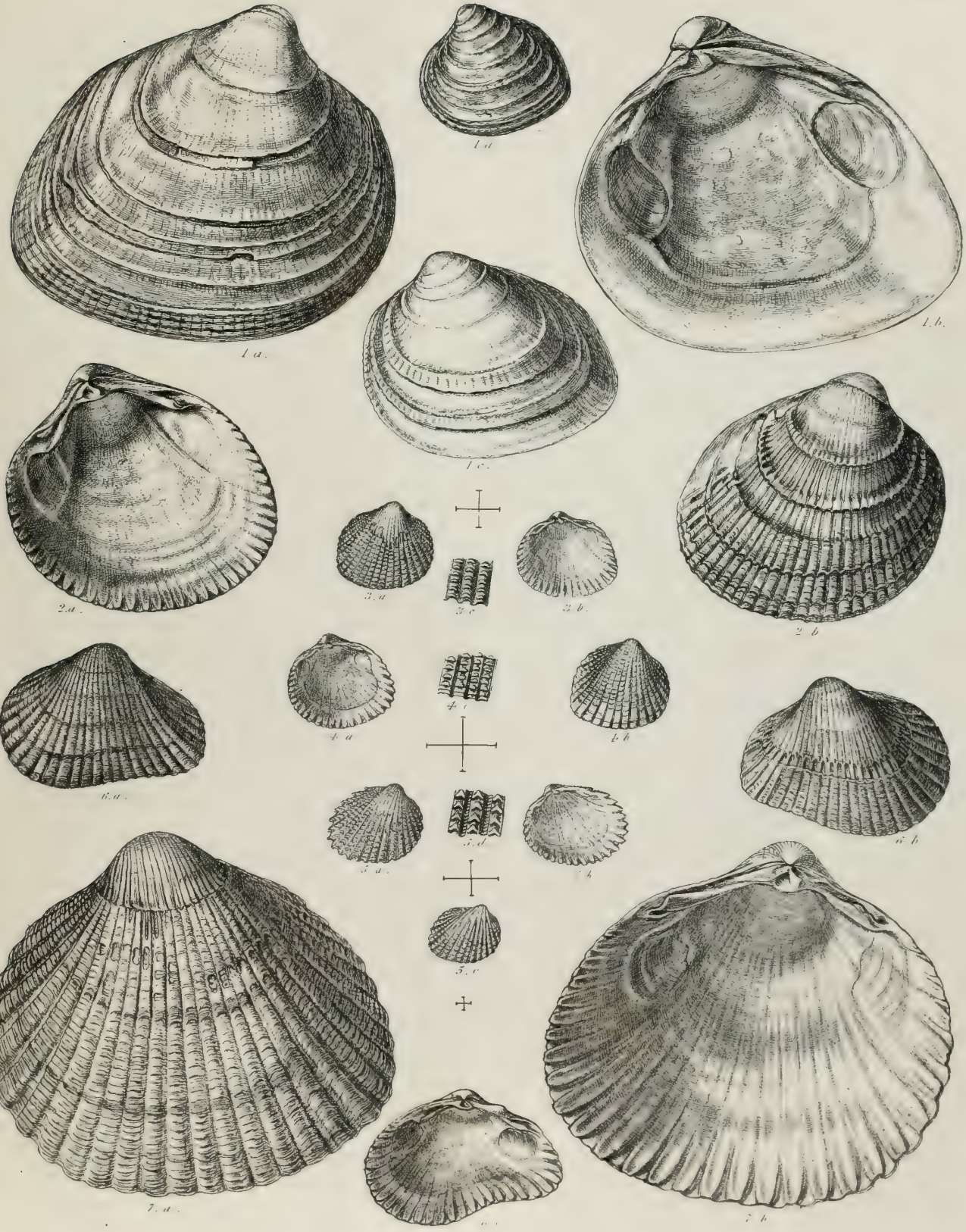
d. „ „ portion of surface magnified.

c. „ „ young specimen, showing the introduction of an intermediate ray.

6 *a—c.* „ angustatum, *p.* 157.

7 *a, b.* „ Parkinsoni, *p.* 158.

The lines indicate the size of the specimens.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1.b.
1.c.
2.a.
2.b
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3.c
3.b.
4.a
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6.a.
6.b
5.a.
5.d
5.b
5.c
7.a.
7.b
8.

TAB. XIV.

Fig.

1 *a—c.* Cardium decorticatum, *page* 159.

d. „ „ (tenellum)

2 *a—g.* „ edule, *p.* 155.

a. Var. vulgaris.

b. „ umbonatum, from Bramerton, Mam. Crag.

c. „ edulinum, from Sutton, Cor. Crag.

d. „ multicostatum, with 28 ribs; from Sutton, Red Crag.

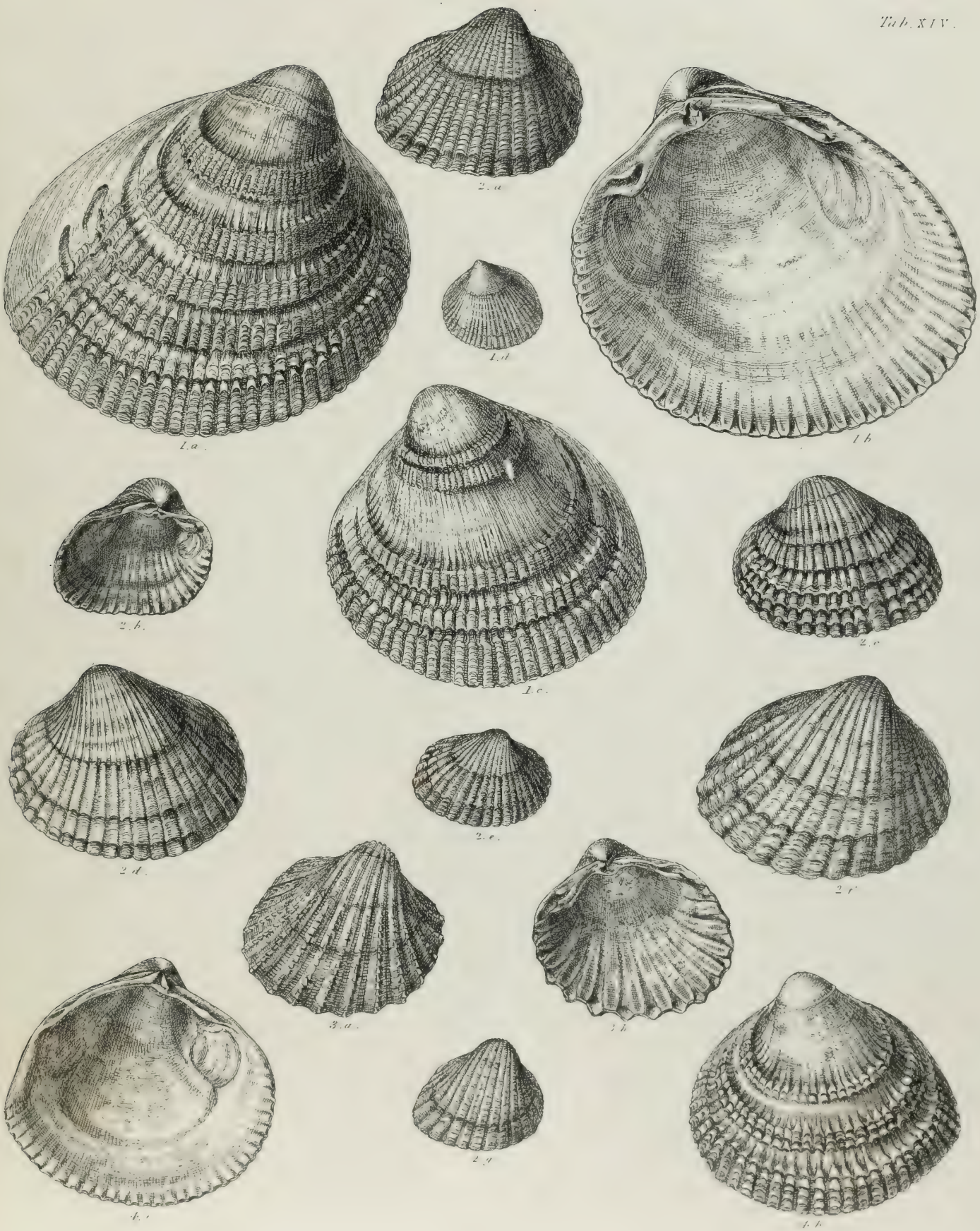
e. „ clodiense, from Sutton, Red Crag.

f. „ inhabile, with 20 ribs; from Sutton, Red Crag.

g. „ paucicostatum, 18 ribs; Bramerton, Mam. Crag.

3 *a, b.* Cardium echinatum, *p.* 152.

4 *a, b.* „ interruptum, *p.* 159.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1.d.
1.b
2.b.
1.c.
2.c
2.d.
2.e.
2.f
3.a.
3.b
4.c
4.g
4.b

TAB XV.

Fig.

1 *a—f.* Cardita senilis, *page* 165.

2 *a, b.* „ corbis, var. nuculina, *p.* 168.

c, d. „ „ „ exigua.

3 *a. b.* „ chamæformis, *p.* 167.

4. „ or bicularis, *p.* 167.

5. „ scalaris, *p.* 166.

6. „ analis, *p.* 168.

7 *a—d.* Coralliophaga cyprinoides, *p.* 200.

b, c. „ „ var. elongata.

d. „ „ slightly enlarged view of the hinge.

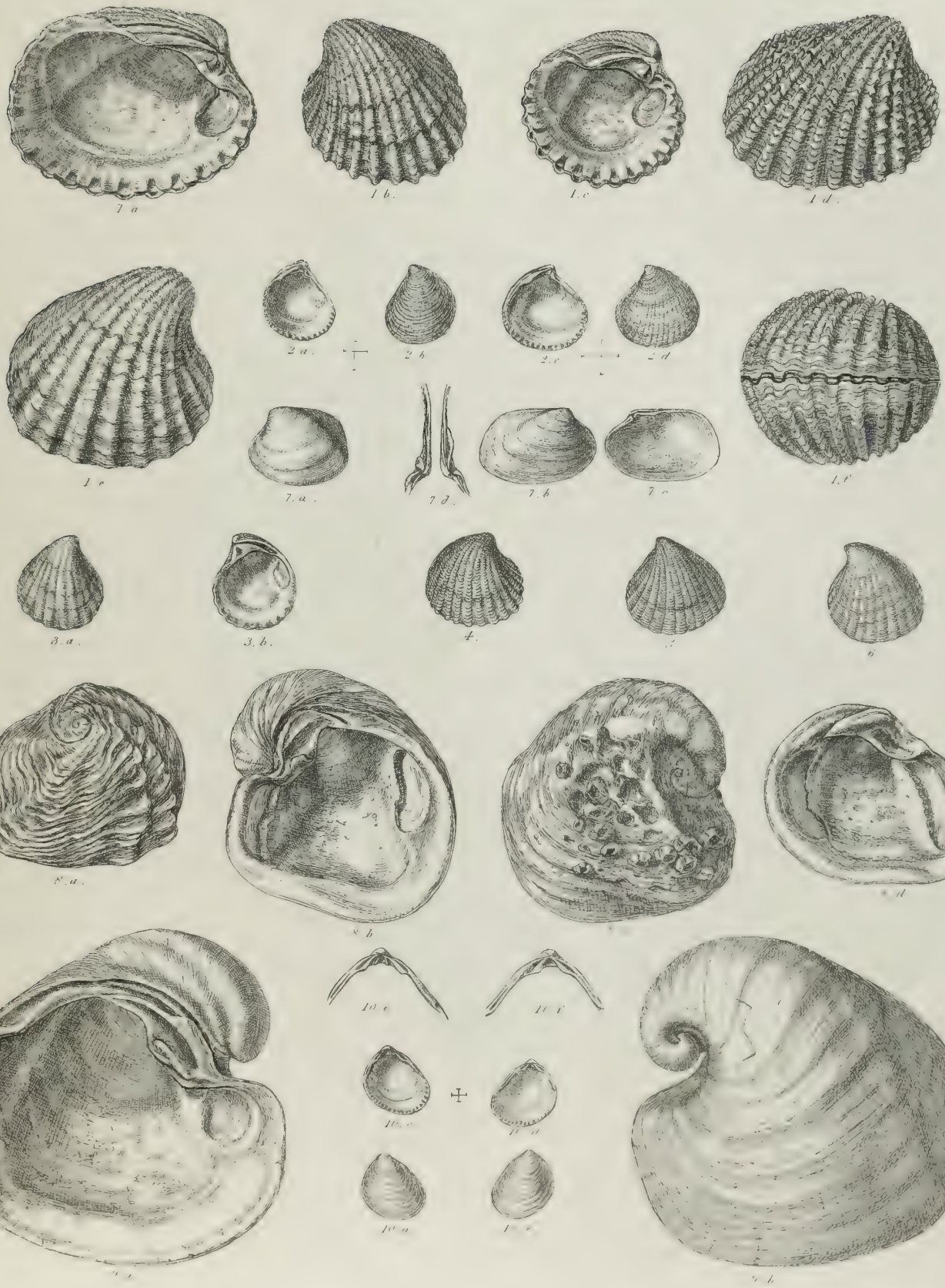
8 *a—d.* Chama gryphoides, *p.* 162.

9 *a, b.* Isocardia cor, *p.* 193.

10 *a—d.* Erycinella ovalis, *p.* 171.

e, f. Enl arged views of the hinge, showing a central cavity of the ligament.

The lines indicate the size of the specimens.



TAB. XVI.

Fig.

1 *a—f.* Astarte mutabilis, *page* 179.

c, d. „ „ var. deformis.

e, f. „ „ specimen from Bridlington.

2 *a, b.* „ crebrilirata, *p.* 184.

3 *a—d.* „ borealis, *p.* 175.

c, d. „ „ var. Withami.

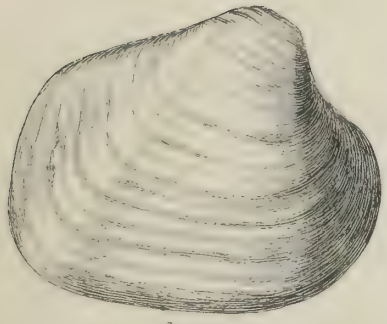
4 *a—d.* „ obliquata, *p.* 189.

5 *a, b.* „ sulcata, *p.* 182.

6 *a, b.* „ incrassata, *p.* 178.

7 „ elliptica, *p.* 181.

8 *a—c.* „ compressa, *p.* 183.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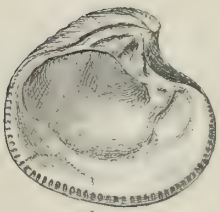
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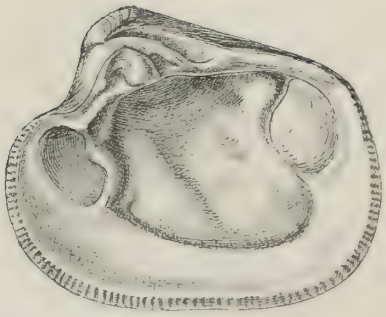
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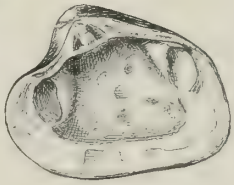
1. d

1. g

1. e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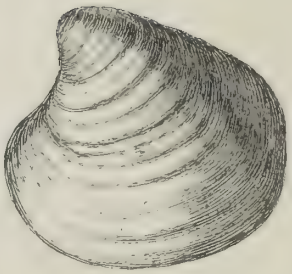
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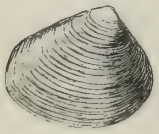
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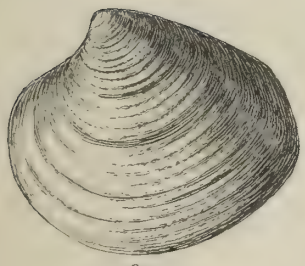
2. b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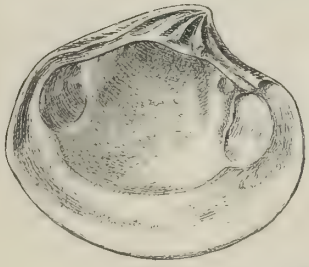
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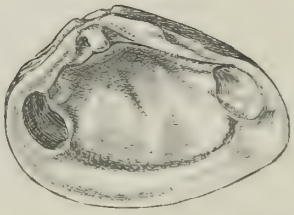
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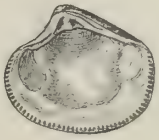
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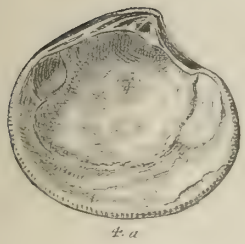
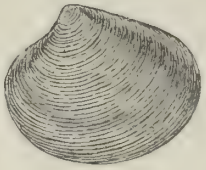
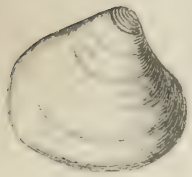

4. a

4. b

f. 5. b


4. c

4. d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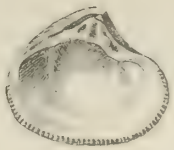
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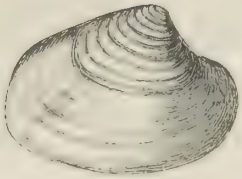
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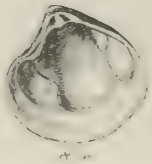
8. a

8. b


8. c

TAB. XVII.

Fig.

1 *a—f.* Astarte Omalii, *p.* 180.

c. „ „ var. undulata.

d. „ „ „ bipartita.

e. „ „ „ acuminata.

f. „ „ „ elliptica.

2 *a—d.* „ Basterotii, *p.* 177.

3 *a—e.* „ gracilis, *p.* 185.

e. „ „ var. multilineata.

4. „ incerta, *p.* 186.

5 *a—d.* „ Burtinii, *p.* 188.

6. „ crebricostata ? *p.* 186.

7 *a, b.* „ pygmæa, *p.* 187.

8 *a—d.* „ digitaria, *p.* 190.

9 *a, b.* „ excurrens, *p.* 191.

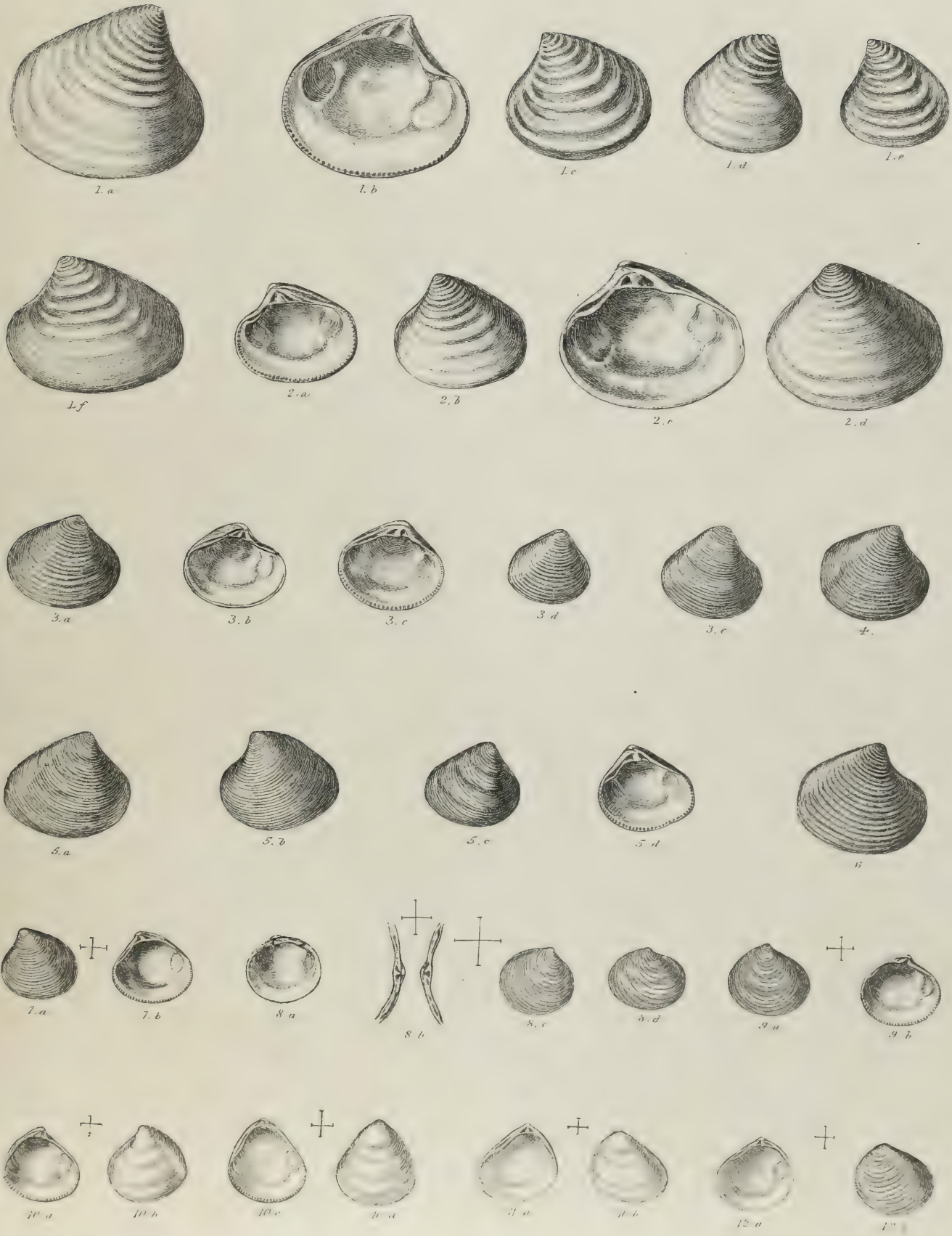
10 *a—d.* „ triangularis, *p.* 173.

a, b. „ „ var. trigona.

11 *a, b.* „ parvula, *p.* 175.

12 *a, b.* „ parva, *p.* 192.

The lines indicate the size of the specimens.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2. d
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3. c
3. d
3. e
4.
5. a
5. b
5. c
5. d
6
7. a
7. b
8. a
8. b
8. c
8. d
9. a
9. b
10. a
10. b
10. c
11. a
11. b
12. a

TAB. XVIII.

Fig.

1 *a*—*e*. Cyprina rustica, *page* 197.

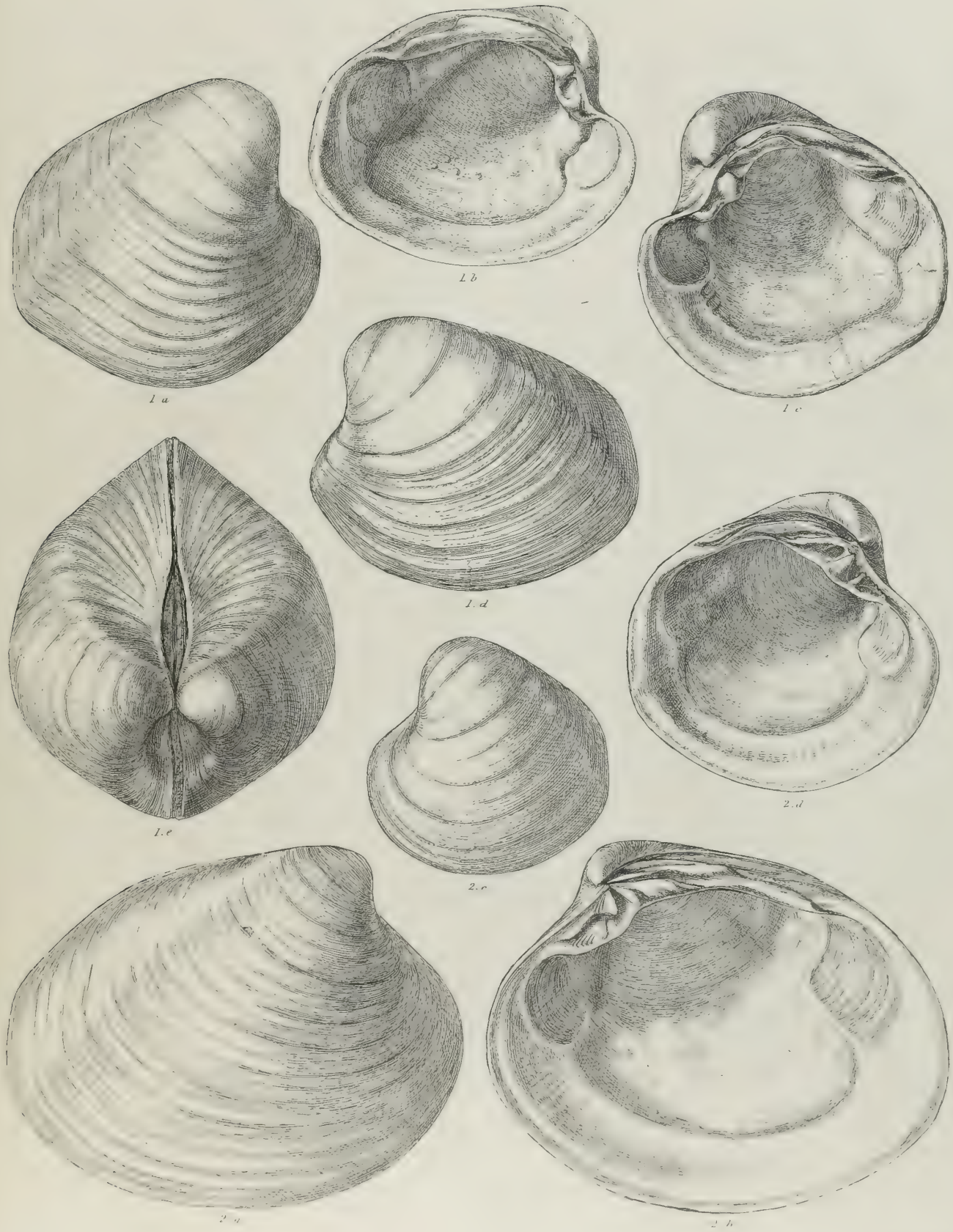
a, *c*, *e*. „ „ var. tumida.

b, *d*. „ „ „ elongata.

2*a*—*d*. „ Islandica, *p*. 196.

c, *d*. „ „ var. orbicularis.

a, *b*. „ „ „ transversa.



1.a

1.b

1.c

1.d

1.e

2.d

2.c

2.a

2.b

TAB. XIX.

Fig.

1 *a—f.* Venus casina, *page* 210.

2 *a—d.* Circe minima, *p.* 198.

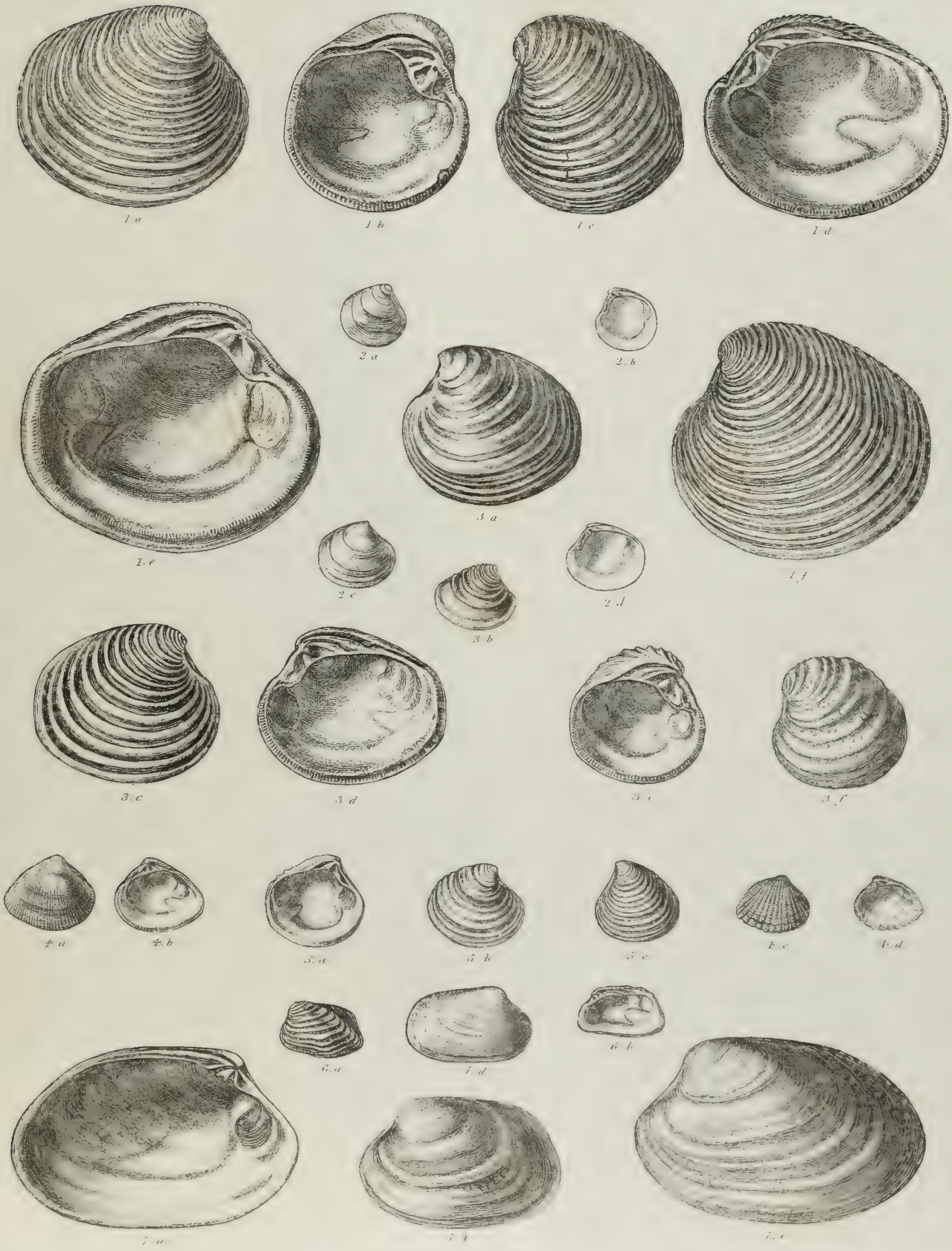
3 *a—f.* Venus imbricata, *p.* 212.

4 *a—d.* „ ovata, *p.* 213.

5 *a—c.* „ fasciata, *p.* 211.

6 *a—b.* Venerupis irus, *p.* 205.

7 *a—d.* Tapes perovalis, *p.* 203.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3 d
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3 f
4 a
4 b
5 a
5 b
5 c
5 d
6 a
6 b
7 a
7 b
7 c

TAB. XX.

Fig.

1 *a*—*e*. Tapes virginea, *page* 201.

c, *d*. „ „ from Mam. Crag, Bramerton.

e. View of sculpture, enlarged two fold.

2 *a*, *b*. Tapes aurea, *p*. 202.

3 *a*—*c*. „ texturata? *p*. 204.

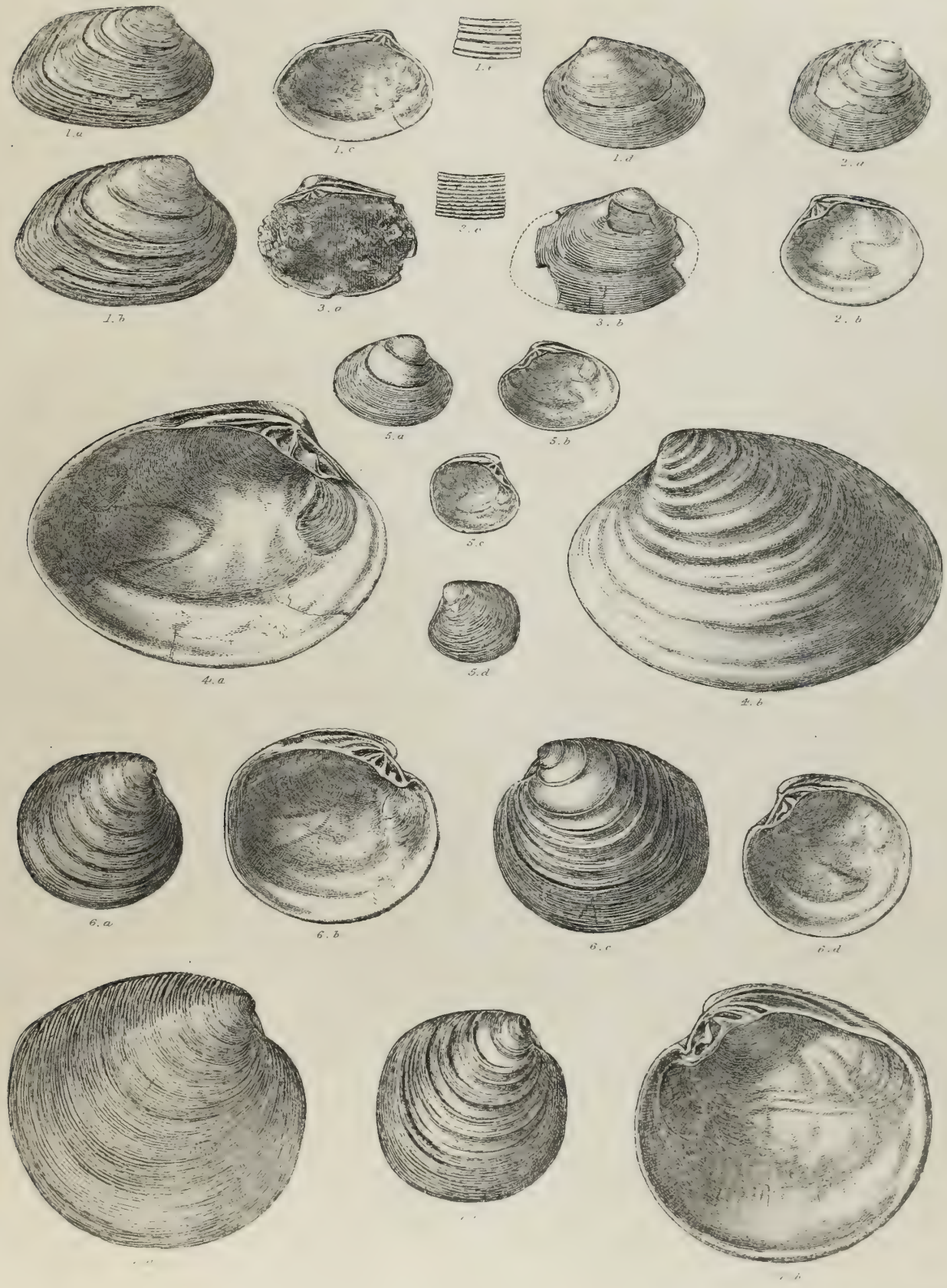
e. View of sculpture, enlarged two fold.

4 *a*, *b*. Cytherea chione, *p*. 207.

5 *a*—*d*. „ rudis, *p*. 208.

6 *a*—*d*. Artemis lincta, *p*. 215.

7 *a*—*c*. „ lentiformis, *p*. 215.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5.b
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4.a
5.d
2.b
6.a
6.b
6.c
6.d
c
c
b

THE

PALÆONTOGRAPHICAL SOCIETY.

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A MONOGRAPH

OF THE

FOSSIL CHELONIAN REPTILES

OF THE

WEALDEN CLAYS AND PURBECK LIMESTONES.

BY

RICHARD OWEN, D.C.L., F.R.S., &c.

LONDON:

PRINTED FOR THE PALÆONTOGRAPHICAL SOCIETY.

1853.

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MONOGRAPH

ON THE

FOSSIL CHELONIAN REPTILES

OF THE

WEALDEN CLAYS AND PURBECK LIMESTONES.

ORDER—*CHELONIA.*

Family—PALUDINOSA.

Genus—Pleurosternon.[1]

In acquiring the requisite materials for the present Monograph, I have had under examination numerous Chelonites from the Wealden series, the majority of which, as in most of the secondary rocks, were more or less fragmentary; indicating, indeed, with sufficient certainty, the order of Reptiles to which they had appertained, but not so perfect as to yield the characters required for determining the family of Chelonia to which they had belonged, much less their relations to the known species of tertiary and existing Tortoises and Turtles.

From the above series of Wealden Chelonites, I have selected for description and delineation those specimens which seemed best to illustrate the nature of the house-carrying Reptiles of the period; and propose to commence with the more perfect specimens which have been extracted from the fresh-water limestones of the Purbeck beds. For the opportunity of examining and figuring the best preserved examples of this kind, I am more especially indebted to William Cunnington, Esq., of Devizes, and to Charles Willcox, Esq., M.R.C.S., of Swanage, Dorsetshire.

[1] Derivation—πλευρον a rib, στερνον the breast-bone.

Genus—PLEUROSTERNON.

Char. Gen.—Testa depressa lata, complanata; sternum integrum, ossibus undecim compositum, per ossiculis marginalibus cum testâ conjunctum; scutis submarginalibus inter scutâ axillariâ et inguinaliâ positis.

As a general rule the vertebrate animals of the secondary strata manifest, in the modifications of their structure, a nearer approach to the archetype of their sub-kingdom than the tertiary and existing vertebrates do. This rule is exemplified in the present genus of Chelonian Reptiles by the accessory osseous pieces that enter into the formation of the plastron, and which are interposed, as an additional pair of bones, between those more constant parial elements called "hyosternals" (*h s*, Tab. III) and "hyposternals" (*p s*, ib.), and which alone articulate with the marginal pieces (*m, m*) in existing Emydians. At least, if we adopt the general homology of the parial elements of the plastron, indicated by the development of that part, viz. as being hæmapophyses, —an increased number of such pieces, making them to that degree more equal in number with the pleurapophyses of the carapace, offers an obvious tendency to a return to the normal type; and the fact of a genus or family of extinct secondary Chelonians manifesting such increase in the number of parial pieces, gives additional support to the conclusions as to the nature of the plastron, arrived at from a study of that part in the embryos of existing species.

By the name *Pleurosternon*, proposed for the remarkable extinct Chelonia about to be described, it is desired to intimate the characteristic furnished by the additional number of inferior rib-elements (hæmapophyses, or "cartilagines costarum" of Anthropotomy) composing the under-shell or plastron, which part naturalists, influenced by the views of Geoffrey St. Hilaire, have usually described under the arbitrary name of "sternum."

The extent of the ossification of the carapace and plastron, and the firm union of the roof and floor of the bony chamber by the medium of the side-walls, afforded by certain marginal plates, prove the genus not to belong to the *marine Chelonia;* the presence of the marginal plates, and the impressions of the horny scutes which covered the carapace and plastron, forbid its being referred to the *fluvial* tribe, represented by the *Trionyces;* the depressed shape of the carapace excludes it from the *terrestrial* tribe of true Tortoises; and we arrive, therefore, by the way of exclusion, to the association of the genus in question with the Terrapenes and other members of the family *Paludinosa* of the eminent Erpetologists, MM. Duméril and Bibron.

PLEUROSTERNON CONCINNUM. *Owen.* Tab^{æ} II and III.

The first specimen of *Pleurosternon* which will be described in the present Monograph is one from the fresh-water limestone of Purbeck, which was kindly transmitted to me by Wm. Cunnington, Esq., for that purpose. It consists of a nearly entire carapace and plastron.

The carapace, Tab. II, includes the nuchal plate, *c h*; the eight neural plates, *s* 1—*s* 8, which are connate with the neural spines of the vertebræ of the carapace; and the corresponding eight pairs of costal plates, except the eighth on the right side, *pl.* 1—8. The hindmost neural plates, and all the marginal plates, save the first of the left side connected with the nuchal plate, are wanting.

The length of the carapace, from the anterior margin of the nuchal plate to the posterior one of the eighth neural plate, is 13 inches; the breadth of the carapace, across the third costal plates, is 11 inches. The outer surface of the carapace is very slightly convex.

The nuchal plate, *ch*, is six-sided; the anterior and antero-lateral borders are of equal length, and are the longest of the six; the hind border is the shortest: the latter is angularly notched for the reception of the first neural plate, *s* 1. The front border is slightly convex, with a feeble median concavity. The greatest breadth of the nuchal plate, which is across the angles between the antero-lateral and postero-lateral borders, is 3 inches 4 lines; the length of the nuchal plate is 2 inches 3 lines. The outer surface of the nuchal plate is impressed by a triradiate groove, indicative of the junction of the two nuchal scutes with each other and with the first vertebral scute, *v* 1. The portion of the median series of bony plates answering to the first neural plate in ordinary Chelonia is divided by a transverse suture into two plates,—a circumstance which corroborates the homology of the neural plates with the median dermal bones of the Crocodilia, and opposes their interpretation as the vertebral spinous processes unwontedly expanded. The indented boundary between the first, *v* 1, and second, *v* 2, vertebral scutes crosses the first neural plate, *s* 1, immediately in advance of the dividing suture in question.

The second, *s* 2, to the eighth, *s* 8, nuchal plates inclusive are six-sided, with the antero-lateral sides or borders the shortest, and the postero-lateral ones the longest; the third, fifth, and eighth are crossed by the boundary impressions between the vertebral scutes. They progressively diminish in length to the seventh; the eighth resuming the normal length, unless the indentation between the fourth, *v* 4, and fifth, *v* 5, vertebral scutes conceal, as I suspect, a suture dividing the plate, *s* 8.

The first pair of costal plates, *pl.* 1, is impressed by the boundary lines dividing the second marginal scute, the first vertebral scute, *v* 1, the second vertebral scute, *v* 2, and the first costal scute, *c* 1; it unites with the nuchal, *c h*, and first and second mar-

ginal plates, with both divisions of the first neural plate, *s'*, with the anterior truncated angle of the second neural plate, *s* 2, and with the second costal plate, *pl.* 2; the second, *pl.* 2, to the seventh, *pl.* 7, costal plates, have the posterior angle of their mesial extremity truncated; they become slightly expanded at their lateral extremity; and, after the third, they gradually decrease in length. The second, fourth, and sixth costal plates, like the first costal plate, bear the impressions of the lines of union of the costal scutes with each other and with the vertebral and marginal scutes: the third, fifth, and seventh costal plates bear the impressions of the lines of union of the costal with the vertebral and marginal scutes. The eighth costal plate is impressed by the line of union between the fourth costal scute and the fifth vertebral scute, and by that of both these scutes with the fourth vertebral scute mesially, and with the tenth marginal scute laterally.

The exterior surface of all the above-described elements of the carapace is minutely wrinkled and granulated, except near the sutural borders, where it is impressed by numerous close-set fine lines, directed at right angles, or nearly so, with those borders. This two-fold pattern is best marked in the costal plates, in most of which the marginal lineated sculpturing extends over about one fourth of the entire breadth of the scute. There are no concentric impressions indicative of the lines of growth of the horny scutes.

The first marginal scutes meet at the middle line on the forepart of the nuchal plate, and do not leave there any median or nuchal scute in the present species. The first and second vertebral scutes are of equal breadth, the succeeding three progressively decrease in breadth: all are six-sided, and broader than they are long, the length and breadth being most nearly equal in the fourth vertebral scute, *v* 4.

The following are the dimensions of the principal vertebral scutes:

	First.		*Second.*		*Third.*		*Fourth.*	
	In.	Lines.	In.	Lines.	In.	Lines.	In.	Lines.
Length, or antero-posterior extent .	2	6	2	11	2	11	3	0
Breadth	4	10	4	10	4	7	3	6

Their shape is sufficiently indicated in the figure, Tab. II; as is also that of the costal scutes, *c* 1 to *c* 4.

In the carapace above described, the greater part of the marginal plates, the eighth costal plate of the right side, and the terminal neural plates, are wanting; but sufficient remains in natural juxtaposition to show that the carapace has been of a full oval figure, broadest anteriorly, with a very slight degree of convexity, and without any special elevations along the median line or at other parts.

The plastron, Tab. III, is a long, rather narrow, flat, oval plate; it was probably rounded anteriorly, but this border is fractured: it contracts from the lateral wall, *h s*, *p s*,

with a gentle sigmoid marginal curve to the hinder apex, *x s*, which is emarginate by a notch with convex borders. The middle third of each lateral border of the plastron is connected, through the medium of three marginal plates, with the carapace. The length of the plastron, as far as it is entire, is 13 inches; its breadth, at the fore part of the lateral walls, is 6 inches 6 lines.

The entosternal element, *s*, is as broad as it is long; its anterior half is defined by two nearly straight borders, which converge at an angle of 45°; its posterior contour is nearly semi-circular; the length of the entosternal is 2 inches 4 lines. The episternal, *e s*, is bounded behind by two nearly straight lines, which meet at an open angle. The hyosternal is remarkable, as in other species of *Pleurosternon*, for the excess of its transverse over its antero-posterior diameter, as compared with the same element of the plastron in other *Paludinosa:* the median sutural border is irregularly wavy: the lateral border unites by suture with the fifth and part of the sixth marginal plates, the anterior border is united by suture at its median half to the entosternal and episternal bones; its lateral half is free, smoothly rounded, and indented by a deep and narrow notch. The outer surface of the bone is impressed by the line dividing the humeral from the pectoral scute, which line is crossed at right angles by the line dividing both the above scutes from the axillary and submarginal scutes.

The supplementary sternal elements, intercalated between the hyosternals, *h s*, and hyposternals, *p s*, and which, from their constancy in the present genus, I propose to denominate, for the convenience of description, the "mesosternals," and which bear the letters *p e* and *a b* in Tab. III, are transversely elongated, quadrate plates of bone, resembling in form the costal plates above, and being their correlatives in the plastron. They are not quite symmetrical in the present specimen, the left one having a greater antero-posterior breadth, and encroaching a little way beyond the median line to the right side of the plastron to join its fellow: at the outer end they articulate with part of the sixth and part of the seventh marginal plates. The mesosternal element is impressed by the line dividing the pectoral, *p e*, from the abdominal, *a b*, scutes; and by that dividing both these from the submarginal scutes. The hyposternals, *p s*, present nearly the same proportions as the hyosternals, *h s*; they unite externally with part of the seventh marginal plates; they are impressed by the straight transverse line dividing the abdominal from the femoral scutes, and by that dividing these from the inguinal scute. The xiphisternals, *x s*, present the form of an inequilateral triangle, and are impressed by the line dividing the femoral, *f e*, from the anal, *a n*, scutes. The forms and proportions of the perishable horny scutes that covered the bony plastron are indicated by the narrow, well-defined impressions of their boundary lines. The line dividing the intergular from the humeral scutes curves across the entosternal at about one third of the length of that bone from its anterior border. The humeral scutes, *h u*, covered the rest of the entosternal, *s*, part of the episternal, *e s*, and the anterior half of the hyosternal, *h s*, bones. The pectoral scutes, *p e*, were transversely elongate, quadrate,

and covered the posterior half of the hyosternals and the anterior third of the mesosternals. The abdominal scutes, *a b*, presented a similar form, and covered the rest of the mesosternals and less than half of the hyposternals. The femoral scutes, *f e*, were longer than they were broad; they joined the abdominal scutes by a straight transverse line; but that between them and the anal scutes, *a n*, describes a curve, with the convexity backwards, and nearly equally divides the xiphisternals, *x s*. In addition to the axillary and inguinal scutes, there are three scutes interposed between the outer borders of the pectoral and abdominal scutes, and the under borders of the fifth, sixth, and seventh marginal scutes: these superadded scutes I propose to call "submarginal scutes." The *Platysternon megacephalum*, or Large-headed Terrapene of the Chinese swamps, presents a corresponding, but single, supplementary "submarginal scute," upon the under part of each lateral production of the plastron. The under surface of the fifth, sixth, and seventh marginal plates bears a crucial impression, indicative of the lines of junction between the marginal and submarginal scutes. The head of the left femur is preserved, near the seventh marginal plate, in the specimen above described.

For the species of *Pleurosternon*, which the above-described specimen, Tab^{æ} II and III, represents, I propose the name of *concinnum*.

PLEUROSTERNON EMARGINATUM. *Owen*. Tab^{æ} IV, V, and VI.

A nearly-allied species, *Pleurosternon emarginatum*, is represented in Tab^{æ} IV, V, and VI. It is from the same formation and locality, and differs from the foregoing chiefly in the contour of the free borders of the plastron. The anterior and posterior marginal plates being preserved in the specimen figured in Tab. IV, and almost all those of the right side in that figured in Tab. V, we obtain a nearly complete idea of the contour of the carapace in this broad and depressed extinct species of Emydian. The nuchal and first marginal scutes are unluckily wanting in the specimen with the upper surface of the carapace exposed, which prevents our determining whether the present species possessed or not the nuchal scute. The neural plate answering to *s* 1 in ordinary Chelonia is divided by a transverse suture in this species, as in *Pl. concinnum*, Tab. II; and the impression of the line of union between the first and second vertebral scutes crosses just in front of the suture of division. The second neural plate, 2, joins the first costal plate of the left side, but not that of the right; and it is pentagonal, the shortest side or border being that which joins the left first costal plate. The third, 3, to the seventh, 7, neural plates inclusive are hexagonal, and resemble in shape those in the *Pleurosternon concinnum;* the eighth neural plate is hexagonal, and is broader than it is long; the ninth neural plate, answering to that bearing the letter *s* 8 in Tab. II, is more expanded at its hinder part; the tenth neural plate, 10, is triangular,

with a truncated apex and a broad rounded base, which articulates with the pygal and adjoining marginal plates.

The costal plates offer nothing particularly worthy of note, in comparison with those of *Pleurosternon concinnum*.

The second and third marginal plates bear not only the impressions of the lines dividing the corresponding marginal scutes from each other, but those dividing the marginal from the first costal scutes. The succeeding costal scutes do not encroach on the marginal plates, which consequently only show the impressions dividing the marginal scutes from each other. Some of the marginal scutes are slightly dislocated, and the posterior ones, from the ninth to the pygal scute inclusive, have their free borders mutilated.

The first vertebral scute, *v* 1, is narrower than the second and third vertebral scutes, instead of being broader, as in *Pleurosternon concinnum*. The second vertebral scute, *v* 2, is proportionally broader behind than is its homologue in *Pl. concinnum*. The fifth vertebral scute, *v* 5, has the three angles of its hinder border sharply produced in the interspaces between the last marginal scutes.

The character of the outer surface of the carapacial pieces resembles that in the *Pleurosternon concinnum*.

The more entire posterior border of the carapace, of which the inner surface is exposed in the specimen figured in Tab. IV, shows it to be slightly emarginate at the middle of that border; and there is sufficient of the anterior border of the same carapace preserved to show that it is more widely and deeply emarginate at the middle of that end.

With regard to the plastron, the lateral borders of the anterior freely-projecting portion are straighter, and those of the posterior portion more uniformly convex, than in the *Pleurosternon concinnum;* the terminal notch has its sides concave instead of convex. The impression of the line dividing the humeral, *hu*, from the pectoral, *pe*, scutes advances at the median plane so as almost to touch the entosternal, *s*. The mesosternals differ from those of the *Pl. concinnum* by the right extending a little to the left of the median line, but not more than may be expected from the admitted extent of variety in different individuals of the same species. The line between the femoral, *fe*, and anal, *an*, scutes is wavy, instead of being simply convex, as in *Pl. concinnum*. The impressions of the three accessory (submarginal) scutes, between the axillary and original scutes, on the right side of the plastron, Tab. VI, are well shown; they have not encroached so far upon the marginal plates as in the *Pl. concinnum*.

The length of the carapace of the *Pleurosternon emarginatum*, in the specimen figured in Tab. IV, is 21 inches 9 lines; the breadth of the carapace is 20 inches. In the specimen figured in Tab$^{\text{æ}}$ V and VI, the breadth seems to have been less; but allowance must be made for the partial dislocation inwards of the broad marginal plates, which,

on the right side, overlap the ends of the costal plates. The entire length of the carapace of this specimen seems to have been about 17 inches; the breadth about $15\frac{1}{2}$ inches.

Pleurosternon ovatum. *Owen.* Tab. VII.

The most beautiful and perfect example of the depressed Emydians, with the complex plastron, from the fresh-water limestone of Purbeck, is that from the collection of Charles Willcox, Esq., M.R.C.S., which, by the liberality of its possessor, has been figured, in Tab. VII, for the present Monograph.

The entire series of marginal plates is preserved with scarcely any dislocation or fracture, in natural connection with the costal plates: they show the carapace to have been nearly elliptical in figure, but a little more pointed, or less obtusely rounded behind than before; it is not emarginate at the anterior border, and was only very slightly so, if at all, at the posterior border. The *Pleurosternon concinnum* resembles the *Pleurosternon ovatum* in the absence of the anterior emargination of the carapace, which distinguishes the *Pleurosternon emarginatum*. The first vertebral scute, *v* 1, is, however, as in that species, narrower than the second, instead of being of equal breadth, as in the *Pl. concinnum:* it covers, also, a larger proportion of the first neural plate, *s* 1, which, moreover, is not divided into two, as in the two previously described species. The place of the fourth neural plate is occupied by the conjoined median ends of the fourth pair of costal plates, ossification having extended continuously from them into the dermal matrix overlying the subjacent neural spine, instead of commencing from that spine or from a separate centre; but this may be an individual variety. It leads, however, to a modification of form of the fifth neural plate, *s* 5, which is pentagonal, instead of being six-sided, as is usual, and as is the case with the two succeeding neural plates. The eighth neural plate expands posteriorly, and the expansion in this direction is progressive in the ninth and tenth neural plates; the eleventh or pygal plate, *p y*, is narrower than the back part of the tenth neural plate, is quadrate, and shows, both by its shape, size, and median impression, that it belongs rather to the category of the dermal marginal plates, the series of which it completes posteriorly. The costal plates, *pl.* 1 to *pl.* 8, offer no modification worthy of notice. There are eleven marginal plates, 1, 1′, to 10, on each side of the carapace, in addition to the nuchal, *c h*, and pygal, *p y*, plates; they increase in breadth after the sixth; the first bears the impression of the triradiate line which marks the division between the first, *m* 1, and second, *m* 2, marginal scutes, and the first, *v* 1, vertebral scute.

There was no nuchal scute. The second, third, and fourth marginal plates were slightly overlapped by the first costal scute, *c* 1. The antero-posterior breadth, in comparison with the transverse breadth, is greater in the costal scutes of the *Pleurosternon*

ovatum than in those of the *Pleurosternon emarginatum*. The number of marginal scutes was twenty-four, twelve on each side, *m* 1 to *m* 12.

The fore part of the plastron appears to have projected in advance of the carapace, as is indicated by the plate of bone marked *e s*, in Tab. VII.

The length of the carapace of the specimen of *Pleurosternon ovatum* here described is 19 inches 6 lines; its breadth is 14 inches 6 lines. It is very slightly convex, with the margins a little raised. The feeble sculpturing of the outer surface of the carapace resembles in general character that of the other species of *Pleurosternon*.

This beautiful specimen is in the Collection of Charles Willcox, Esq., M.R.C.S.

PLEUROSTERNON LATISCUTATUM. *Owen*. Tab. I.

The species represented by the specimen of mutilated carapace, Tab. I, differs from all the other recognised species of the genus by its distinct nuchal scute, *c h*, by the small relative size of the first vertebral scute, *v* 1, and by the great relative size, more especially the superior breadth, of the three succeeding vertebral scutes, *v* 2, *v* 3, *v* 4. The boundary lines, indicating the forms and disposition of the horny scutes, are proportionally larger and deeper than in the other species of *Pleurosternon* described in the present Monograph.

The sutures uniting together the different elements of the carapace are more dentated or wavy than those in the other species, more especially the suture uniting the nuchal plate with the first neural plate and first pair of costal plates. The neural plates, from the first to the seventh inclusive, are similar in form, six-sided, with the antero-lateral sides the shortest; the eighth neural plate is the smallest, is four-sided, and broadest behind; the ninth and tenth neural plates are remarkable for their great breadth.

The transverse extent or length of the costal plates is considerable, in accordance with the great breadth of the carapace: the eighth costal plate, in this respect, differs considerably from its homologue in the other species of *Pleurosternon*. The second marginal scute is not produced backwards between the first vertebral and first costal scute, but, like the first and third marginal scutes, has its antero-posterior diameter much less than the diameter in the direction of the periphery of the carapace. The first, *c* 1, and fourth, *c* 4, costal scutes differ considerably in their forms and proportions from those in Tables II, V, and VII.

The outer surface of the osseous parts of the carapace of *Pleurosternon latiscutatum* is minutely punctated and rugose, except near the sutural borders of the several pieces, where it is impressed by rather coarse parallel striæ, directed at right angles to those borders.

Of this well-marked species of *Pleurosternon*, I have seen portions of the fossil carapace of several individuals, from the Purbeck limestone; the most complete of

these fossils is represented, of half the natural size, in Tab. I. This specimen is now preserved in the Museum of the Philosophical and Natural History Society of Dorchester.

Chelone costata. *Owen.* Tab. VIII.

From the Wealden Clays of Tilgate Forest have been obtained many fragmentary Chelonites, indicative of species representing two of the actual families of the order, viz. *Paludinosa* and *Marina;* and such, therefore, as might be expected to be met with in the deposits of a large estuary. I propose to commence the description of these Wealden Chelonites by those which indicate a species of the marine family.

Portions of the carapace and plastron, and bones of the extremities of a large species of Turtle, some of them indicating individuals with a carapace nearly three feet in length, form part of the Mantellian collection, purchased by the British Museum: a few of these Chelonites have been figured in Dr. Mantell's 'Illustrations of the Geology of Sussex,' 4to, 1822.

The author of that work has not deduced any specific characters from these fossils, and the nature of most of the specimens hardly allowed their determination to be carried closer than to the marine family of *Chelonia*.

With regard to one of the specimens (Pl. VI, fig. 2), however, Mr. Clift's authority is quoted for its resemblance with the corresponding part of the *Chelone imbricata,* and Dr. Mantell acknowledges that "as Cuvier had referred the turtles of Melsbrock to the *Emydes,* we at first entertained doubts whether our approximation of this specimen to the *Cheloniæ* were correct. Mr. Clift's remark, however, tends to confirm the opinion that it belongs to a marine turtle." (Op. cit., p. 62.)

After a careful comparison of the specimens in the British Museum, I have come to the conclusion that the Wealden species differs from the *Chelone imbricata, Chelone carinata,* and other recent species, in as great a degree as do most of the extinct *Chelones,* in the greater extent of ossification of the costal interspaces and of the plastron.

A characteristic portion of the great Wealden Turtle is represented, of the natural size, in Tab. VIII of the present Monograph. It includes the second and third marginal plates, and considerable portions of the first and second costal plates, with the connate portions of the pleurapophyses, or vertebral ribs. These are remarkable for their breadth and prominence, and have suggested the name proposed for the present species of Wealden *Chelone*.

In the same plate are represented a mutilated right iliac bone, fig. 3, and the right femur of, probably, the same species of Turtle. These, also, are from the Wealden formations of Tilgate Forest, and form part of the Mantellian Collection now in the British Museum.

Figure 4, Tab. IX, gives a view of the inner surface of the left hyposternal, half the natural size of, probably, the same species of *Chelone*. It is imbedded in a slab of Wealden stone.

As compared with existing Turtles, the ossification of the plastron is more advanced or more extensive, the rays of bone from the outer and inner free borders of the hyposternal being shorter and their interspaces more filled up. A nearer approach is thus made in this Wealden species, as in some of the Eocene Turtles, to what may be regarded as the more general type of the Chelonian carapace.

PLATEMYS MANTELLI. *Owen.* Tab. IX, fig. 1.

Report on British Fossil Reptilia, 1841, p. 167.

EMYS DE SUSSEX, *Cuvier.* Ossemens Fossiles, 4to, tom. v, part ii, 1824, p. 232.

EMYS MANTELLI, *J. E. Gray.*

Amongst the Chelonian Fossils obtained by Dr. Mantell from the Wealden strata of the Tilgate Forest, in Sussex, were certain specimens, the resemblance of which to the flat species of Emydian, or terrapene, discovered by M. Hugi in the Jura limestone at Soleure, has been pointed out by CUVIER, (loc. cit.) Both the Jura species and the Wealden Chelonites in question are referable to the 'pleuroderal' section of the great tribe *Paludinosa*, as arranged by Messrs. Duméril and Bibron;[1] and, in that section, to the genus *Platemys*, but so much of the skeleton has not, as yet, been discovered, as to afford a ground for a good specific character of the so-called *Emys Mantelli*.

The most intelligible fragment in the British Museum, is that element of the plastron—the hyosternal; which is figured in Tab. IX, fig. 1. The proportions of this bone indicate that the plastron of the *Platemys Mantelli* consisted of the ordinary nine pieces: where the accessory pair of mesosternal pieces is introduced, both the hyo- and hypo-sternals have relatively less antero-posterior extent than the fossil in question shows.

PLATEMYS, sp. dub. Table IX, fig. II.

A second species of Wealden *Platemys* is apparently characterised by a somewhat broader plastron, and by a greater relative thickness of the bones composing both this and the carapace. Without the latter difference, the proportionally broader plastron might be merely the sexual distinction of the female of the first species. Some difference, in the shape of the axillary notch of the hyosternal further induces me to regard the fragmentary Chelonites in question, of which a hyosternal is figured in Tab. IX, fig. II, as belonging to a second species of Wealden *Platemys*.

[1] Erpetologie, 8vo, 1835, tom. ii, pp. 172, 372.

PLATEMYS DIXONI. *Owen.* Table IX, fig. III.

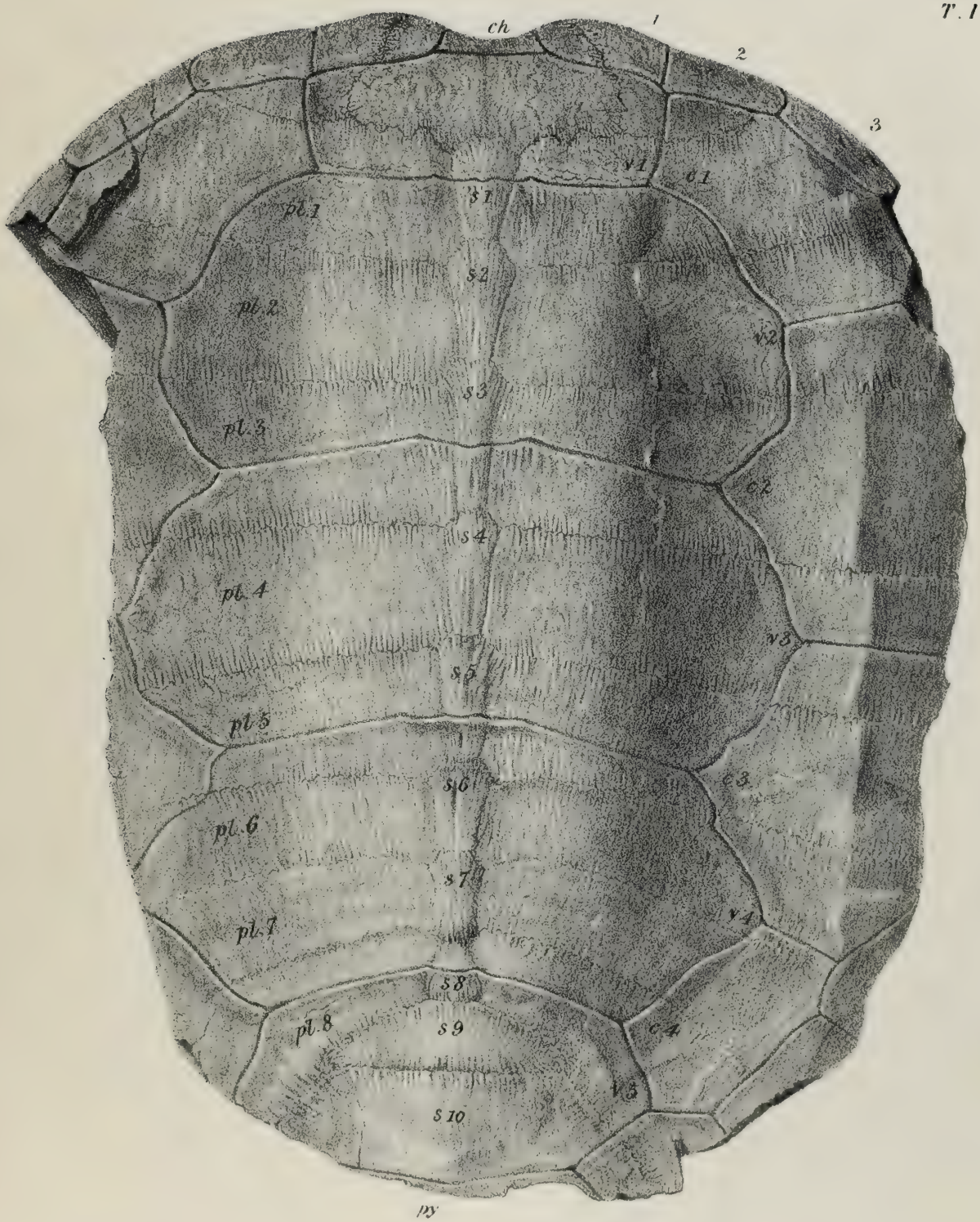
A platemydian specifically distinct from either of the above is more unequivocally exemplified by the sternal element represented in Tab. IX, fig. III, the matrix having been carefully removed from the outer surface of this fossil, the linear impressions which have divided the humeral from the pectoral scute, and this from the abdominal scute, are clearly shown. The positions of these transverse grooves accord with those in the hyosternal of the Emydians, having the usual number (nine) of plastral elements: and the hyosternal character of the fossil is further shown by the oblique border cutting off the inner angle of the anterior end, for articulation with the entosternal element. (This end has been figured downwards in the plate.) The axillary groove is narrower than in the above-described species; and the whole bone seems to have been longer in proportion to its breadth. It is from the Wealden of Tilgate Forest, and is now in the British Museum. I propose to dedicate the Wealden terrapene, indicated by the above-described fossil, to my late esteemed friend, Frederic Dixon, Esq., F.G.S., author of the beautiful work 'On the Cretaceous and Tertiary Formations of Sussex.'

TABLE I.

HALF NAT. SIZE.

The carapace of *Pleurosternon latiscutatum*. (The letters and figures are explained in the text.) From the Purbeck Limestone. In the collection of Charles Willcox, Esq., M.R.C.S., Swanage, Dorsetshire.

T. 1.



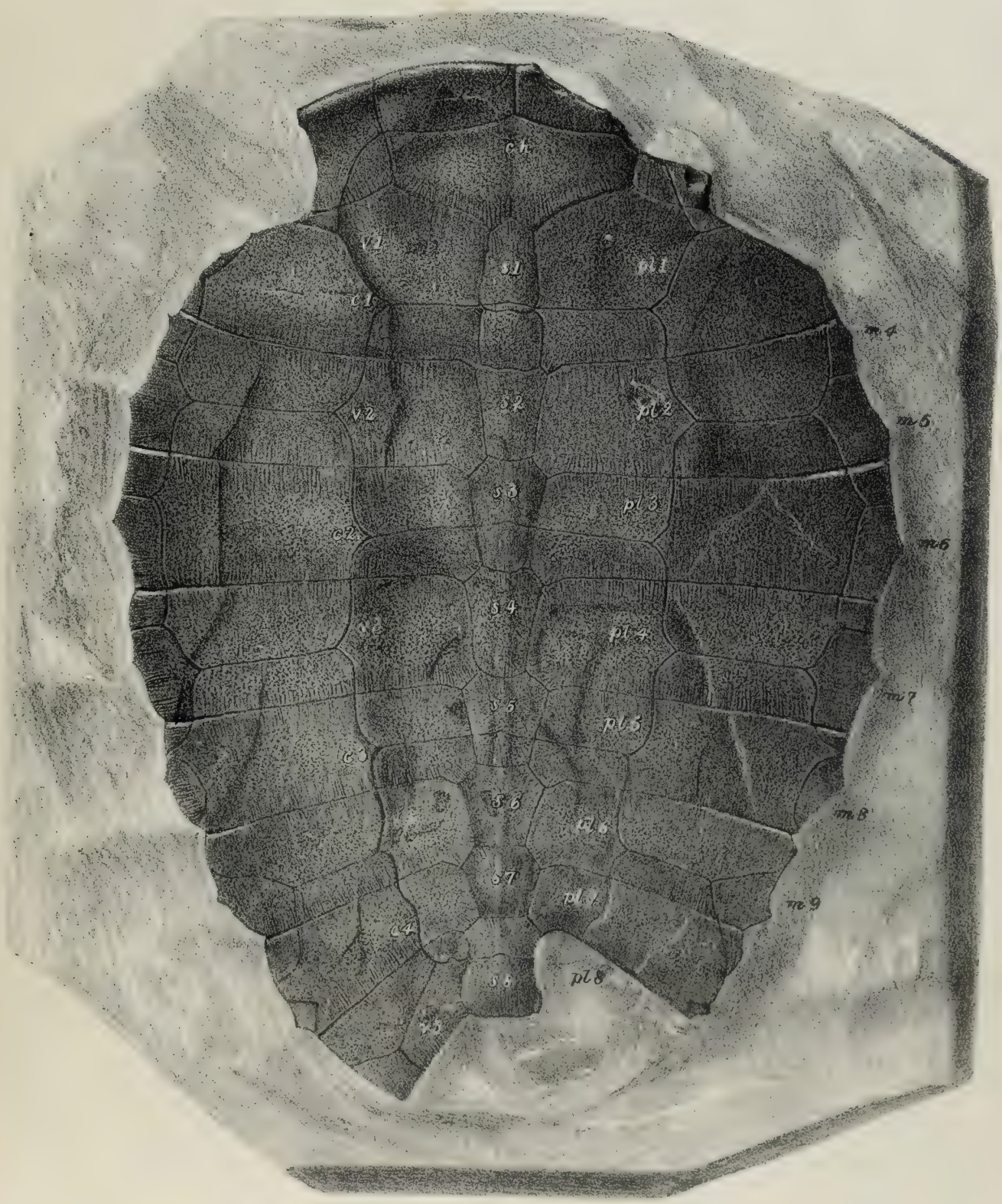
J. Dunkel del. et lith.

Day & Son Lith.rs to The Queen

TABLE II.

HALF NAT. SIZE.

The carapace of *Pleurosternon concinnum*. (The letters and figures are explained in the text.) From the Purbeck Limestone. In the collection of William Cunnington, Esq., of Devizes, Somersetshire.

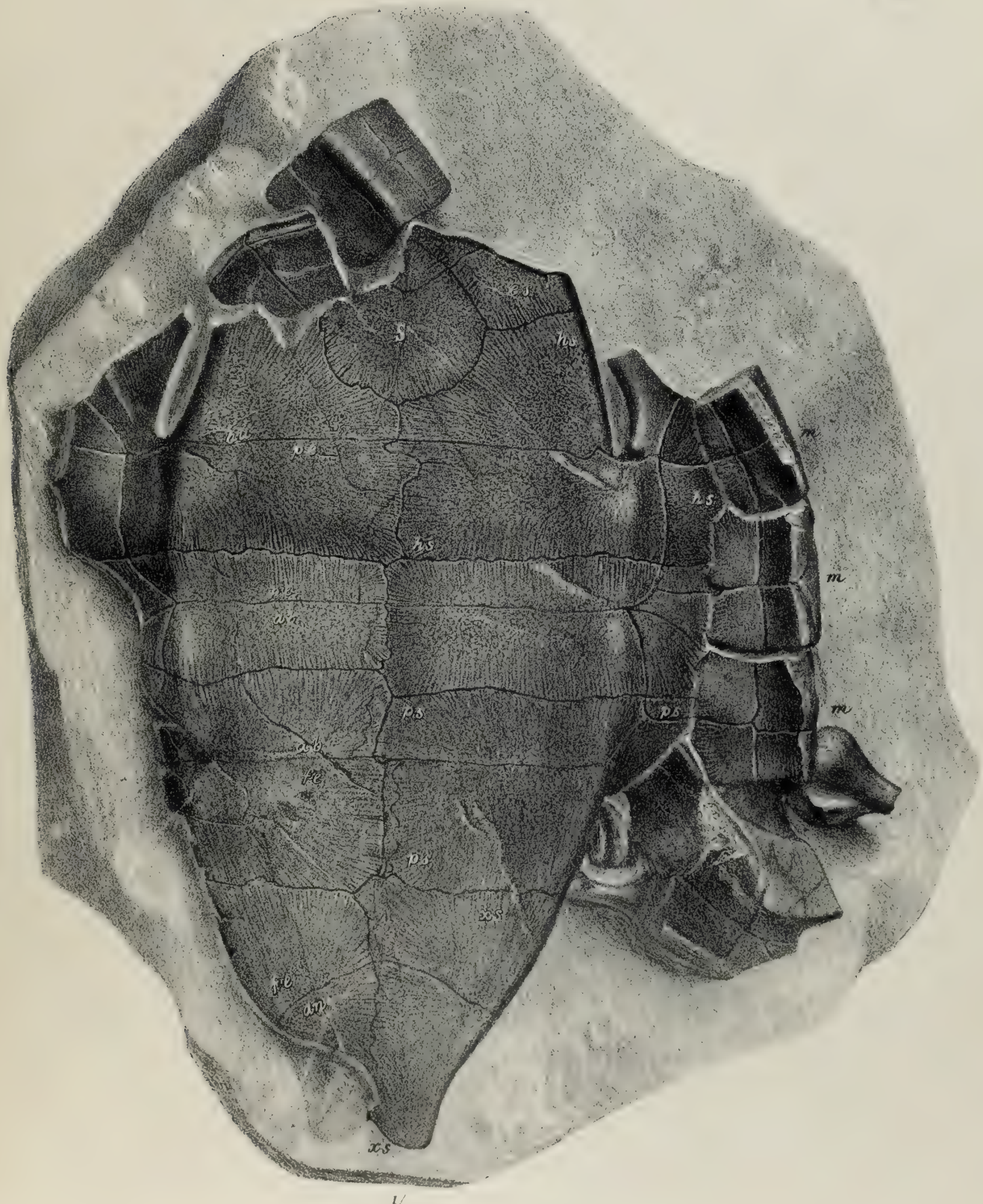

c h.
v 1
s 1
pl 1
c 1
m 4
v 2
s 2
pl 2
m 5
s 3
pl 3
c 2
m 6
s 4
pl 4
v 3
m 7
s 5
pl 5
c 3
s 6
pl 6
m 8
s 7
pl 7
m 9
c 4
s 8
pl 8
v 4

1/2

TABLE III.

HALF NAT. SIZE.

The plastron of *Pleurosternon concinnum*. (The letters and figures are explained in the text.) From the Purbeck Limestone. In the collection of William Cunnington, Esq., of Devizes, Somersetshire.



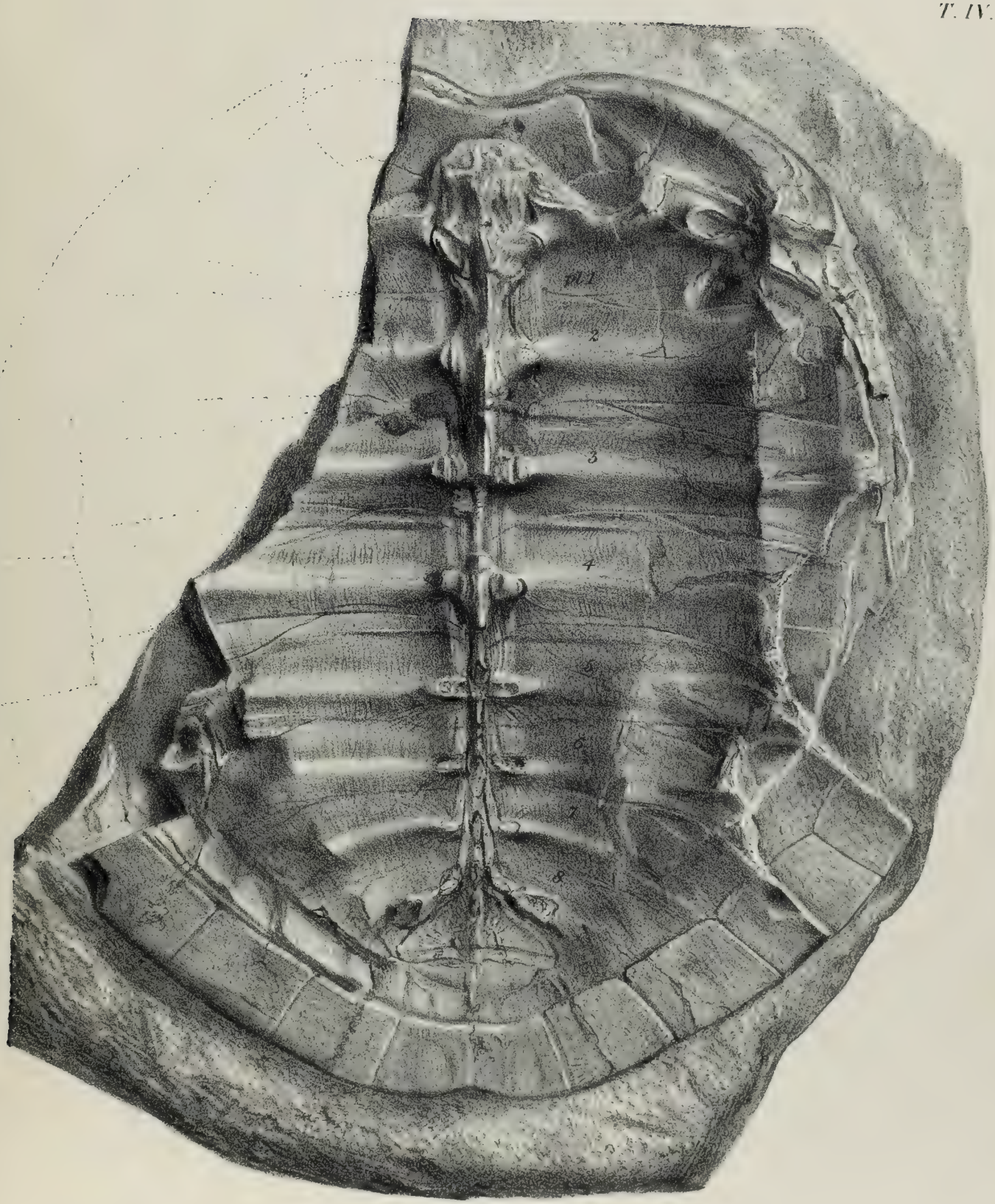
Drakel lith.

TABLE IV.

ONE THIRD NAT. SIZE.

The inner surface of the carapace of *Pleurosternon emarginatum*. From the Purbeck Limestone. In the collection of Charles Willcox, Esq., M.R.C.S., Swanage, Dorsetshire.

T. IV.



Dinkel del et lith

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TABLE V.

HALF NAT. SIZE

The carapace of *Pleurosternon emarginatum*. (The letters and figures are explained in the text.) From the Purbeck Limestone. In the collection of Charles Willcox, Esq., M.R.C.S., Swanage, Dorsetshire.

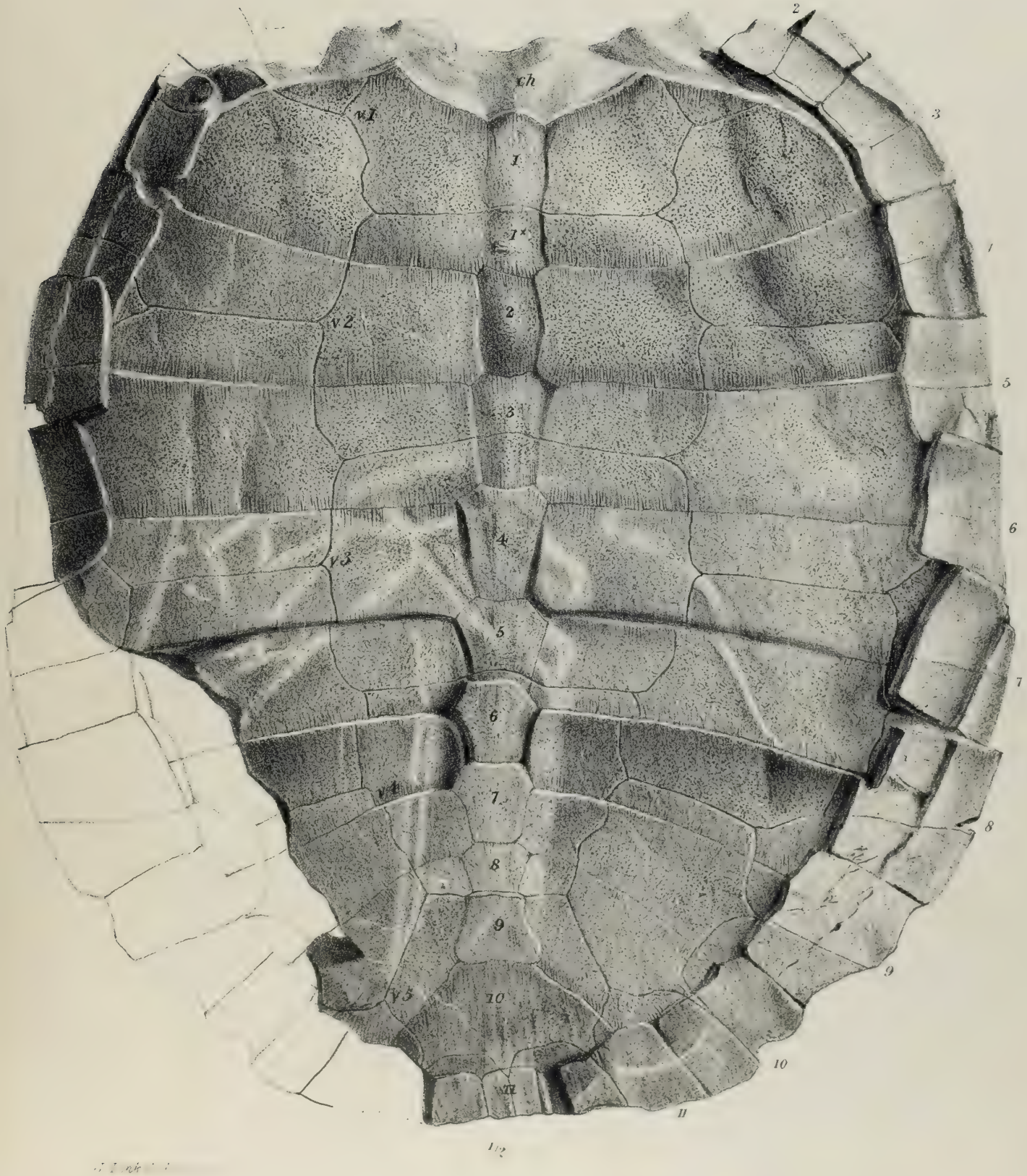
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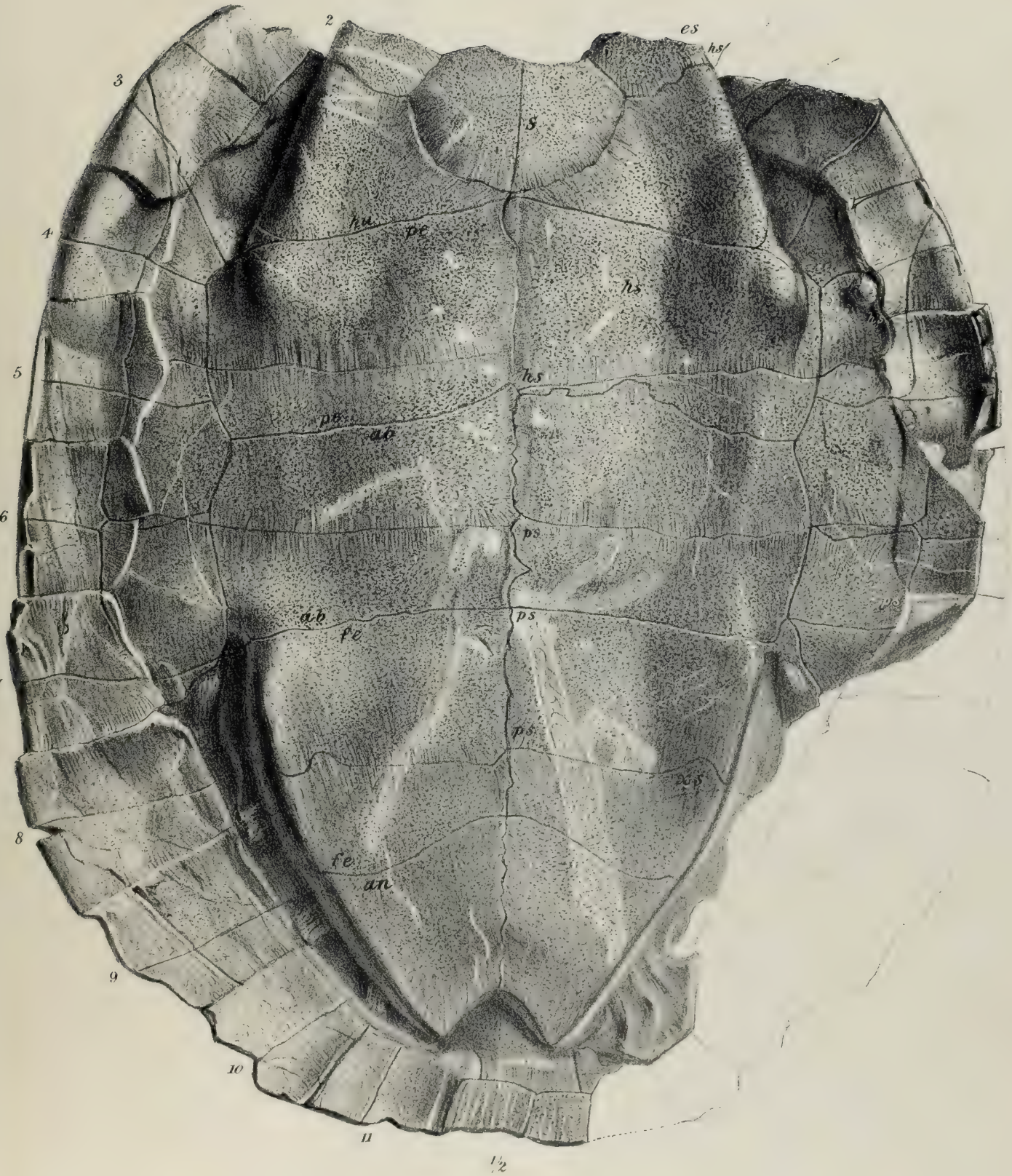
TABLE VI.

HALF NAT. SIZE.

The plastron and marginal plates of *Pleurosternon emarginatum*. (The letters and figures are explained in the text.) From the Purbeck Limestone. In the collection of Charles Willcox, Esq., M.R.C.S., Swanage, Dorsetshire.

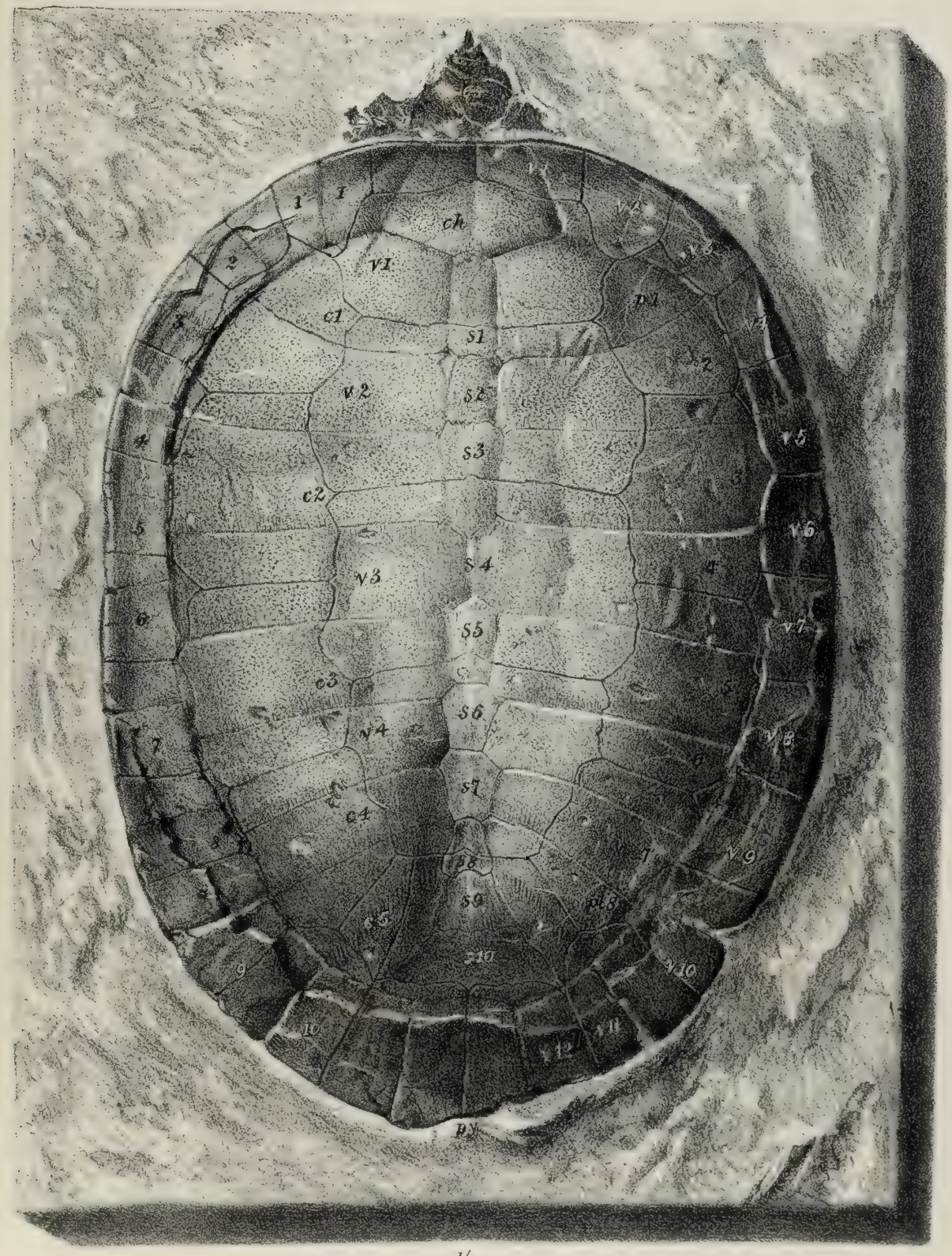


Lambe del et lith

TABLE VII.

ONE THIRD NAT. SIZE.

The carapace of *Pleurosternon ovatum*. (The letters and figures are explained in the text.) From the Purbeck Limestone. In the collection of Charles Willcox, Esq., M.R.C.S., Swanage, Dorsetshire.



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Jos Dinkel, del. et lith

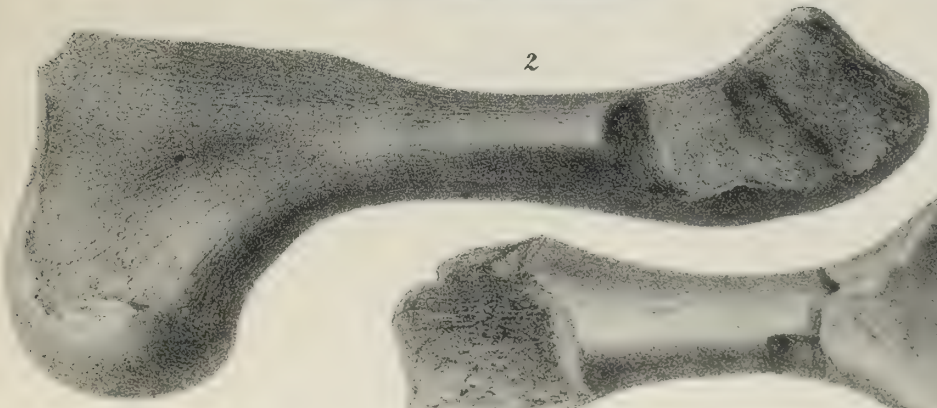
Day & Son, Lith.rs to The Queen.

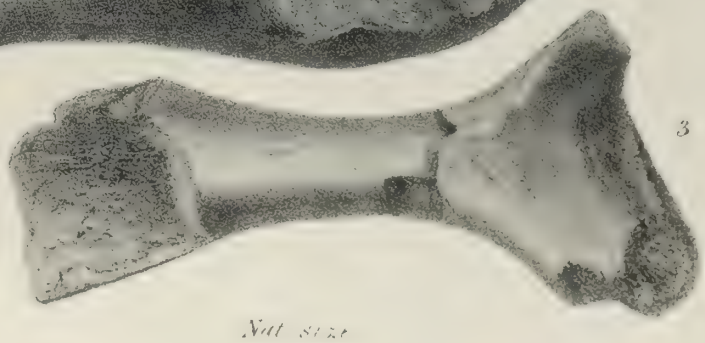
TABLE VIII.

Fig. 1. Inner surface of a portion of the carapace of *Chelone costata*, nat. size. From the Wealden of Tilgate Forest. Mantellian Collection, in the British Museum.

Fig. 2. The right femur of *Chelone costata*, nat. size. From the Wealden of Tilgate Forest. Mantellian Collection, in the British Museum.

Fig. 3. The right iliac bone of *Chelone costata*, nat. size. From the Wealden of Tilgate Forest. Mantellian Collection, in the British Museum.





Nat. size.

Day & Son, Lith.rs to The Queen

TABLE IX.

Fig. 1. The inner surface of the right hyosternal bone of *Platemys Mantelli;* half nat. size. From the Wealden of Tilgate Forest. Mantellian Collection, in the British Museum.

Fig. 2. The inner surface of a portion of a hyosternal bone of another species of *Platemys;* half nat. size. From the Wealden of Tilgate Forest. Mantellian Collection, in the British Museum.

Fig. 3. The left hyosternal bone of *Platemys Dixoni;* half nat. size; (figured upside down.) From the Wealden of Tilgate Forest. Mantellian Collection, in the British Museum.

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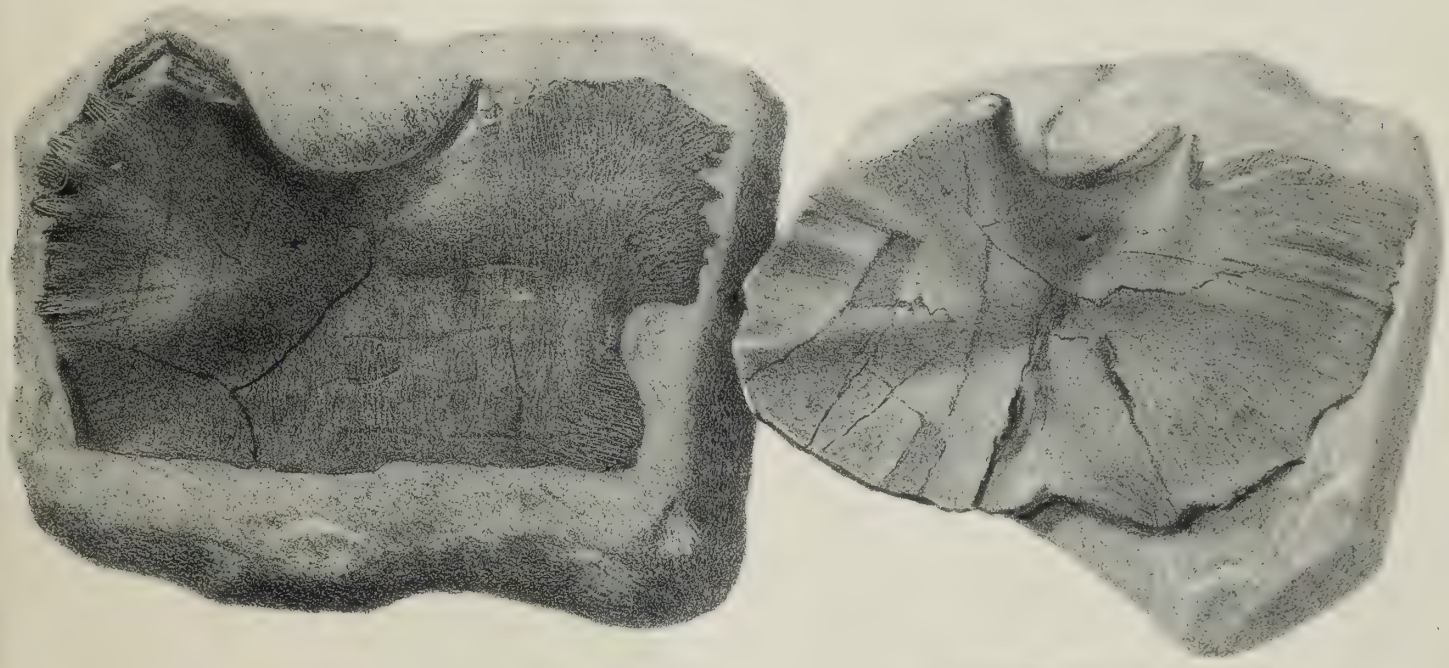

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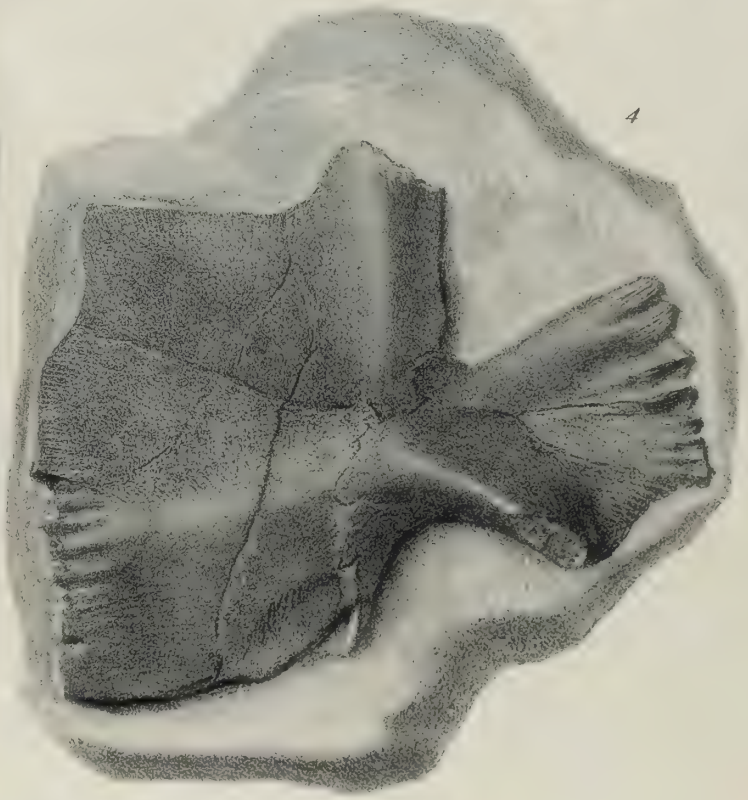

Half Nat. size.

Jos. Dinkel. del. et lith

Day & Son. Lith. to the ...

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